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AUTOPSY MANUAL

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE

JULY 1960

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FOREWORD

This Autopsy Manual has been prepared at the Armed Forces Institute of Pathology.

This revised Autopsy Manual provides the prosector with ready and concise criteria on post-mortem procedures and examinations. Its publication is presented as a guiding directive toward uniformity in the selected techniques and objectives of an autopsy. It contains much new information such as the section devoted to procedure in the relatively new field of Aviation Pathology. Forensic Pathology has received additional space and attention. Procedures in toxicological and virology investigations have been stressed.

Though this manual is issued primarily to meet the requirements of the Armed Forces and other federal agencies its value could well extend into civilian laboratories and civilian medicine.

ACKNOWLEDGEMENTS

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NAVY, AND THE AIR FORCE

WASHINGTON 25, D. C., *1 July, 1960*

AUTOPSY MANUAL

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Purpose and Scope

This manual is intended to provide medical officers of the Armed Forces with ready and concise criteria on post-mortem procedures and examinations and to insure uniformity in the selected techniques and objectives of an autopsy. The material presented herein is applicable without modification to both nuclear and non-nuclear warfare.

2. Definitions

a. Autopsy. An autopsy is a scientific post-mortem examination of a dead body, performed to reveal the presence of pathologic processes, their relation to clinical phenomena and history, and to determine the cause or causes of the changes encountered.

b. Medicolegal Autopsy (ch. 6). A specialized type of autopsy authorized or ordered by proper legal authorities in cases of accidental, suicidal, homicidal, unattended, or unexpected deaths in order to protect society and insure justice for the purpose of determining the cause of death.

3. Extent of Autopsy

Whatever type of autopsy is performed, the examination should not be restricted to only those situations which are the seat of obvious alteration, but should include all the organs of the body, for the normality of certain viscera is often as significant as the disease of others, and organs that appear normal macroscopically are frequently abnormal microscopically. An exception to the foregoing is where the authority to conduct the autopsy derives from the consent of the next-of-kin and such consent has limited the extent of the autopsy. In this event, the extent of the autopsy should not exceed the extent of the consent.

4. Responsibility

It is the responsibility of the pathologist to acquaint the clinician with information obtained from the autopsy. This information is used by the clinician to aid in establishing the cause or causes of death before he signs the death certificate.

Section II. AUTHORITY

5. Jurisdiction Over Dead Bodies for Purpose of Autopsy

a. Deceased Military Personnel. An autopsy will be performed on the remains of any person who dies in the military service while serving on active duty or active duty for training when the commander or the surgeon of an installation or command deems such procedure necessary in order to determine the true cause of death, and to secure information for the completion of military records.

b. Other Deceased Persons. When an autopsy is deemed necessary in the case of retired personnel or nonmilitary persons who die in a military medical treatment facility or on a military installation, written permission from the next-of-kin will be obtained before the autopsy is performed. An opinion should be obtained from the local judge advocate defining "next-of-kin" for the jurisdiction in which the installation is located. When authorization for an autopsy is required, such authorization will be obtained on SF 523 (Clinical Record—authorization for Post-Mortem Examination). If permission is unobtainable, and an autopsy is required to complete records of death in compliance with local, state, or Federal law, report will be made to civil authorities for necessary action.

c. Authority to Order Autopsy. In the case both of deceased military personnel and all other deceased persons, whether or not the death occurs on a military reservation, a coroner, medical examiner, judge, or other defined state legal authority has no authority to order an officer or employee of the military services to perform an autopsy. Authority of officers and

employees of the military services to conduct autopsies must derive from regulations or other directives of the military service concerned.

6. Post-Mortem Examinations and Other Dispositions of Remains or Tissue for Purposes Other Than Autopsy

a. No authority to conduct post-mortem examinations on either military or nonmilitary personnel for purposes other than to determine the cause of death and complete medical records exists in the absence of permission of the next-of-kin, to be obtained as in paragraph 5*b*.

b. It is the policy of the military services to dispose of remains in accordance with the wishes of the person recognized as having the right to direct disposition of the remains, provided there is strict compliance with the law of the competent jurisdiction in which the case arises. Accordingly, the written consent of the person who may direct disposition of remains, must be obtained prior to obtaining human tissue from any deceased. Such consent must be obtained even in cases where the deceased has left written instructions such as in a will, and even where state law provides for giving effect to instructions of deceased. Written consent will be obtained on SF 523B (Clinical Record—Authorization for Tissue Donation).

c. While authority for post-mortem examination is not required for an autopsy on an aborted fetus, such procedures does require the consent of the mother to do whatever is done to both mother and fetus, e.g., removal, dissection, photographing, or retention of the fetus.

7. Special Problems Outside CONUS

Outside CONSUS, each service will have special problems which require consultation with appropriate legal authority. Most such problems involve a conflict between or among the laws of two or more jurisdictions.

CHAPTER 2

TECHNIQUE OF THE AUTOPSY

Section I. INSTRUCTIONS

8. Preparatory Measures

a. Before he performs the autopsy, the pathologist should familiarize himself with the clinical history, clinical diagnosis, and special points of interest to the clinician. Direct consultation with the responsible clinician is desirable. A complete review of the patient's hospital records will furnish valuable information and may indicate special procedures which otherwise might not be carried out.

b. The final typed autopsy protocol must include a clinical abstract for reviewing pathologists who do not have access to the clinical records.

c. The prosector should be familiar with chapter 6 in the case of medicolegal autopsies and Armed Forces Directives in appendix I. The body must be identified. The prosector must assure himself that the autopsy is authorized.

d. During the autopsy the prosector will ligate all major blood vessels in a manner that will permit recovery of the vessels during the embalming. It is desired that the ligatures be of sufficient length and firmly tied to facilitate recovery. The degree of consideration given by the prosector will have a strong influence on the eventual quality of preservation and appearance of the body.

9. Inspection

a. Both the anterior and posterior surfaces should be scrutinized. The more important observations include signs of violence, fractures, recent or healed wounds and lacerations, identifying marks, such as tattoos, edema of the legs, back, scrotum, or face, distention of the abdomen, jaundice, hemorrhage from the orifices of the body, hemorrhage into the subcutaneous tissues or cornea, decubital ulcers, abnormal pigmentation, tumors, anomalies, deformities, distribution of hair and subcutaneous fat, and symmetry of the trunk and extremities. The oral and nasal cavities should be examined and the state of the mucosa noted. The number, character, and state of preservation of the teeth may be indicative of certain lesions or diseases. The eyelids should be elevated and the color, size, and shape of both pupils recorded, with other pertinent observations. The external genitalia should be examined.

b. If the patient has received radioactive material, precautions are indicated in paragraphs 105 and 106.

10. Primary Incision of Thorax and Abdomen

a. The usual incision for both men and women is the Y-shaped incision indicated in figure 1. This begins at a point near the acromial extremity of the clavicle, extends in a curve below the corresponding breast to the xyphiod process of the sternum, and thence in similar manner to the opposite acromial extremity. From the xyphoid process, the incision is extended downward in the midline to the symphysis pubis, passing to the left of the umbilicus and not entering the peritoneum.

b. When the autopsy permit restricts examination to the thorax or abdomen, the skin incisions should be modified to allow individual exposure of either of these cavities without cutting into the skin of the adjacent restricted area (fig. 1). Transforming the lower end of the abdominal incision into an inverted V allows easier dissection of the inguinal region and the femoral triangle (fig. 1). An extension of the primary incisions down the anteromedial aspect of the arm may be made as shown in figure 1; however, special permission is required.

c. The peritoneum is incised with scissors, or with a knife placed between two of the prosector's fingers as guides to avoid injury to the intestines or other viscera. The attachments of the abdominal wall to the costal border are severed to lay open the abdominal cavity. Transverse incisions of the rectus muscles are made when necessary to permit easier access to the peritoneal cavity. The incision over the thorax should extend through the skin, subcutaneous

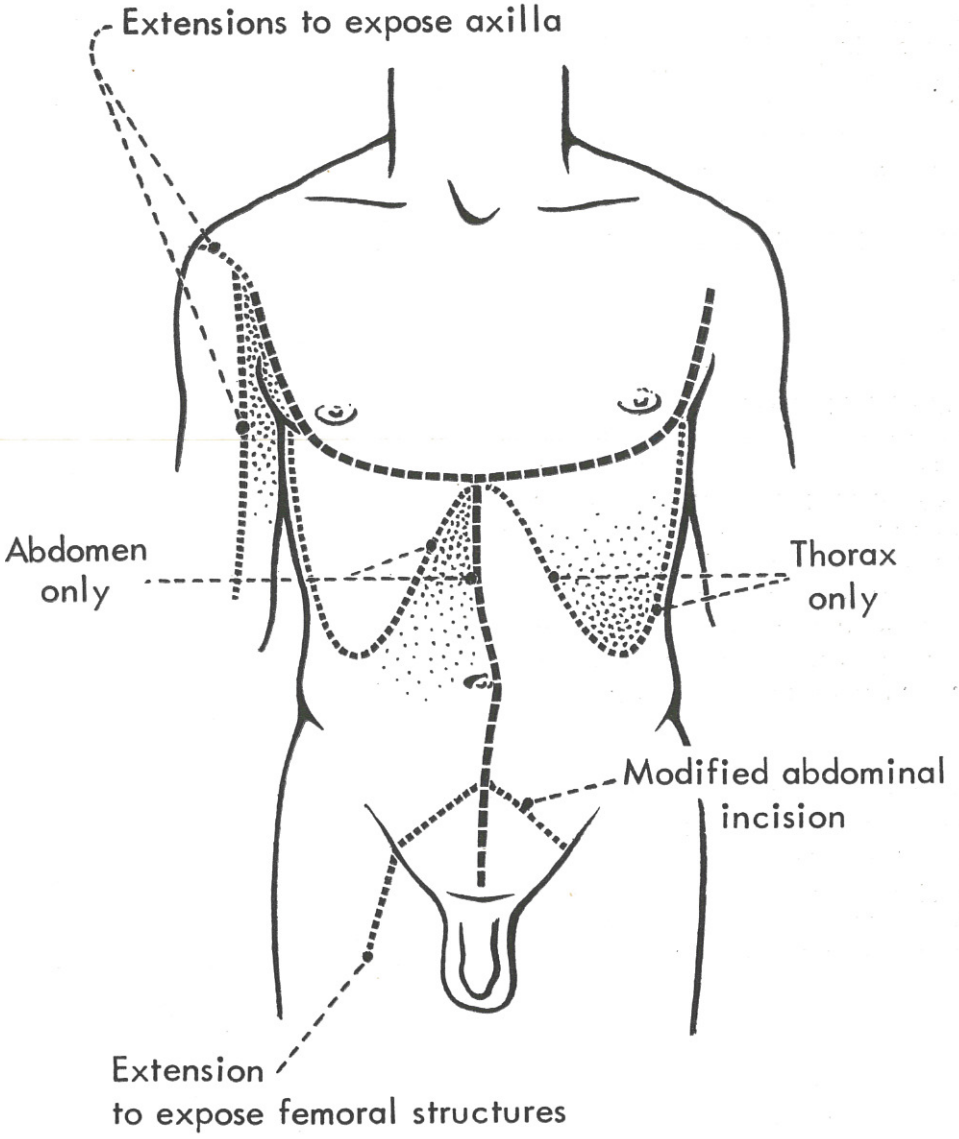
Extensions to expose axilla
Abdomen only
Thorax only
Modified abdominal incision
Extension to expose femoral structures

Figure 1.

fat, and muscle, so that these tissues can be dissected away from the bony thoracic wall as far superiorly as 2 cm. above the sternoclavicular joints.

11. Skin

Random ellipses of skin, 2 to 3 cm. in length, may be obtained adjacent to the primary incision. Lesions noted in the external examination may be removed by excising a small ellipse which includes the subcutaneous tissue as well as the dermis. The *skin of the face, neck, arms, and hands must not be incised except when specific permission is granted.* If more than one lesion is removed, each should be placed in a separate bottle and the site of origin indicated on the label.

12. Inspection of the Peritoneal Cavity and Abdominal Organs

The amount of fluid, the character of the surfaces, and the presence of adhesions should be noted. The size, character, and position of the omentum may yield information concerning focal lesions within the abdomen. The size and relative position of each of the viscera should be observed in relation to fixed landmarks; for example, the liver might be noted as extending so many centimeters below the right and left costal margins in the mid-clavicular lines.

13. Fluid in Peritoneal Cavity

Cultures and smears should be obtained if indicated (pars. 90–97). When the amount of fluid in the cavity is increased, save at least 50 cc. in a clean dry vessel. If warranted, determine the specific gravity and the character of the cells in the centrifugal sediment.

14. Exposure and Inspection of the Thoracic Viscera

a. If pneumothorax is suspected, insert a 16 gauge needle, attached to a 25 cc. syringe filled with water, through an intercostal space into the pleural cavity. Bubbles will appear in the syringe if there is air under pressure.

b. Open the thorax by cutting the costal cartilages just medial to the costochondral junction. The knife should always be directed away from the subject's face to avoid possible damage. Use a heavy cartilage knife for this purpose, with the edge of the blade parallel to the surface of the body to prevent the point from entering the pleural cavity and puncturing a lung. If the cartilages are calcified, rib shears or a saw must be used. Disarticulate the sternoclavicular joints by cutting the capsular ligaments. Sever the first rib with rib shears. Dissect the diaphragm free from the lower ribs on both sides, and remove the triangular "chest plate" to expose the heart, superior mediastinum, and pleural cavities. It is advisable to place a hemostat on the internal mammary arteries and veins on each side as they turn from the sternum to enter the superior mediastinum. This will prevent the leakage of blood into the pleural cavities before they have been inspected.

15. Pleural Cavities

a. The pleural cavities should be inspected before they are contaminated by the prosector's hands. If indicated by the appearance of the fluid or by the history, take samples for culture. When there is appreciable fluid, save 50 cc. in a clean vessel and determine its specific gravity if necessary. The cells can be studied by making smears of the sediment.

b. If there are slight fibrous adhesions, they may be freed by blunt dissection, but if the adhesions are dense it may be necessary to cut around the diaphragm and separate the parietal pleura from the underlying intercostal muscles and ribs in order to remove the lung. If dense adhesions are broken by force, the adjacent lung tissue is often torn.

16. Thoracic Duct

The prosector should develop the habit of displaying the thoracic duct routinely. It is difficult to demonstate and must be located before other dissections in the thorax are carried out. Lift the entire right lung from its cavity and draw it to the left side of the body, anterior to the left thoracic cage. This maneuver exposes the right side of the posterior mediastinum. The thoracic duct is located between the aorta and the azygos vein, close to the vertebrae. Opposite the fifth thoracic vertebrae the duct inclines toward the left side and enters the superior mediastinal cavity. It ends by opening into the angle of junction of the left subclavian vein with the left internal jugular vein. The thoracic duct is most easily found just above the

diaphragm, to the right and behind the aorta. It can be traced inferiorly below the diaphragm where it joins the cisterna chyli located in front of the second lumbar vertebra.

17. Pericardial Cavity

The pericardial cavity is opened by a linear incision from below, cutting to the base. Note the amount of fluid, the condition of the surfaces, and the presence of adhesions. A specimen of the heart's blood may be taken for culture if indicated (pars. 90–97).

18. Superior Mediastinum

Do this dissection after removal of the heart and lungs so that the pericardial and pleural cavities will not be obscured by blood, or divide the left innominate vein between ligatures as it crosses high in the superior mediastinum, so that the three major branches of the arch of the aorta can be fully visualized. Ligate these branches as close to the parent vessel as feasible (fig. 2). The ligatures should be at least 15 inches long after they are tied. The vessels are now severed below the ligatures and the long strings left attached as an aid to the embalmer in locating the vessels. The thymus or its remnants should be dissected from the tissues of the superior mediastinum, weighed, measured, and examined. Fix all or part of the thymus for microscopic study.

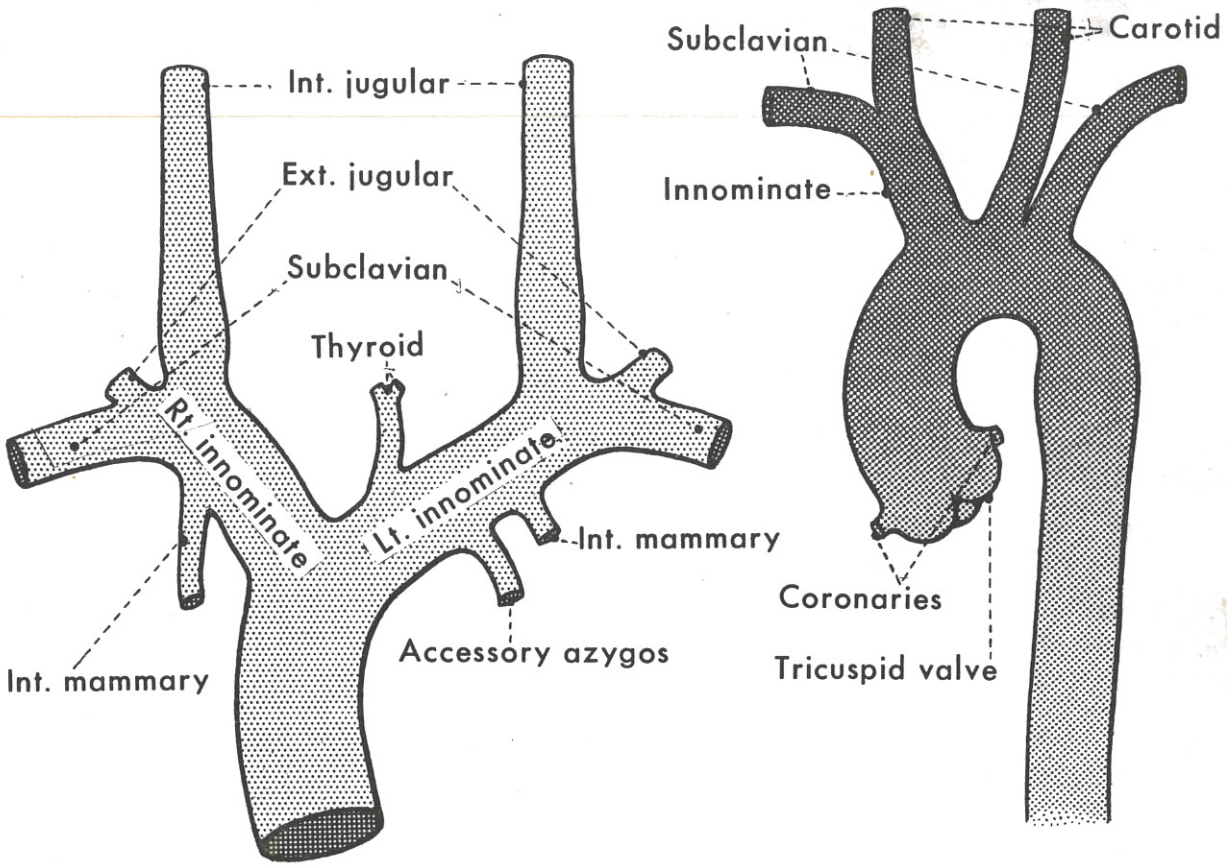

Figure 2

Section II. GENERAL PRINCIPLES IN DISSECTION AND EXAMINATION OF THE VISCERA

19. General Considerations

a. The following general considerations should be borne in mind in the dissection of the viscera:

(1) The primary incisions in each organ should be so placed as to—

(*a*) Expose the largest possible surface.

(*b*) Open the structures that enter through the hilum.

(*c*) Make visible the ductal and vascular systems.

(*d*) Preserve the orientation and relations of the organ.

(2) All further incisions should, as far as possible, parallel the first.

b. No organ should be separated from a connecting structure until the intervening tissue has been dissected and examined; for example, the ostia of the renal arteries, the renal arteries and veins, and the ureters should be examined before the kidneys are removed from the body; the ampulla, the bile ducts, the gallbladder, the portal vein and the hepatic artery should be examined before the liver is separated from the stomach and the duodenum; and the mesentery, mesenteric arteries and veins should be explored before the intestine is separated from the mesentery.

c. All viscera except the heart should be weighed and measured before they are sectioned. Blood is lost from the cut surface and the weight may be reduced as much as 20 percent. In general the weight, the greatest length, breadth and depth should be recorded. In some organs special measurements are indicated; for example, the circumference of the heart valve rings, the thickness of the walls of the heart, of the cortex and of the combined cortex and medulla of each kidney. See appendix III, table I, for normal weights and measurements.

d. The blocks to be selected for histological study are indicated under the separate organs. In all cases the prosector should use his judgment in the removal of additional blocks to illustrate specific lesions. (ch. 7).

e. All calculi should be saved in a clean dry vessel for subsequent chemical analysis, if indicated.

20. Removal of Viscera

Two general methods are available, each of which must be modified to meet special situations and the preferences of the prosector. These are: "Organ by Organ Removal" (pars. 21–59) and "Removal of the Viscera En Masse" (pars. 60–73). A third method, "Removal by Systems" is a compromise between the two. It is not described in this manual though it has many advantages and is used by many pathologists.

Section III. ORGAN BY ORGAN REMOVAL

21. Heart

a. Inspect and palpate the heart *in situ.* Make a longitudinal incision in the pulmonary artery and examine for emboli (A–1, fig. 3). Elevate the apex of the heart and sever the inferior vena cava, and the pulmonary veins at their pericardial reflection. Place traction directed inferiorly on the heart and sever the superior vena cava, the aortic valve and the pulmonary artery. Remove the heart from the pericardial sac. Sever the previously opened pulmonary artery 2 cm. above the pulmonary valve (A–2, fig. 3). Dissect the proximal portion of the pulmonary artery from the underlying root of the aorta (B, fig. 3); this allows the aortic valve to be opened later without cutting through the pulmonary artery. Open the coronary arteries by a series of transverse incisions spaced about 2 mm. apart (fig. 4).

b. The preferred method of opening the heart is to follow the blood flow. Dissect the heart as follows: Insert an amputation knife or scissors in the opening of the inferior vena cava and cut through to the opening of the superior vena cava. Use of the grooved director is helpful in making this incision (C–3,fig. 3). Open the right auricular appendage with an oblique incision beginning at the center of the previous incision (C–4, fig. 3). Cut through the right lateral border of the heart by directing the knife through the tricuspid valve (D–5, fig. 3).

c. Open the outflow tract of the right ven-

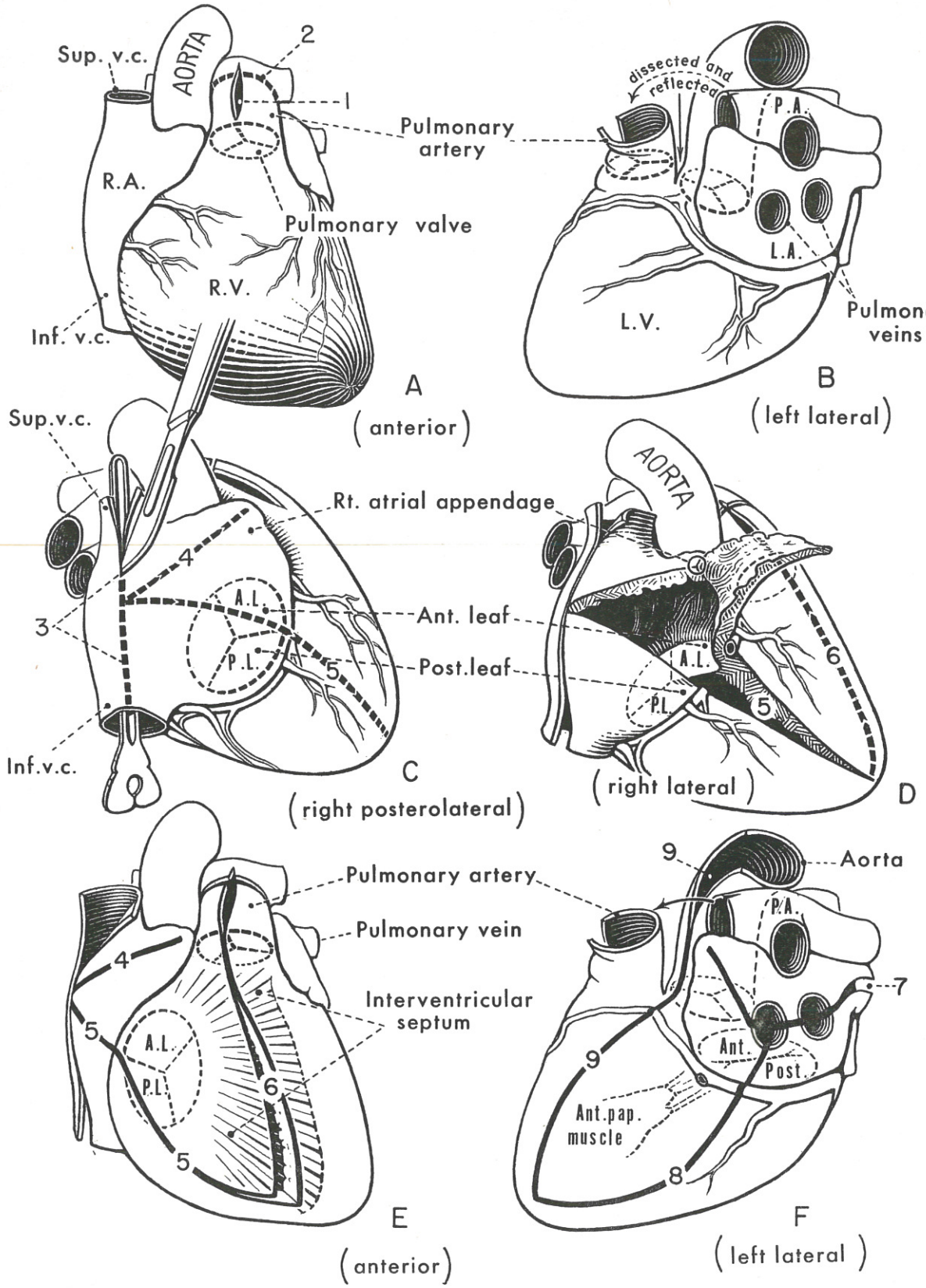
Sup. v.c.
AORTA
2
1
Pulmonary artery
R.A.
Pulmonary valve
R.V.
Inf. v.c.
A
(anterior)
dissected and reflected
P.A.
L.A.
L.V.
Pulmonary veins
B
(left lateral)
Sup.v.c.
Rt. atrial appendage
4
3
A.L.
Ant. leaf
P.L.
Post.leaf
5
Inf.v.c.
C
(right posterolateral)
AORTA
A.L.
P.L.
6
5
(right lateral)
D
Pulmonary artery
Pulmonary vein
4
5
A.L.
P.L.
Interventricular septum
6
5
E
(anterior)
9
Aorta
P.A.
7
Ant.
Post.
9
Ant.pap. muscle
8
F
(left lateral)

Figure 3.

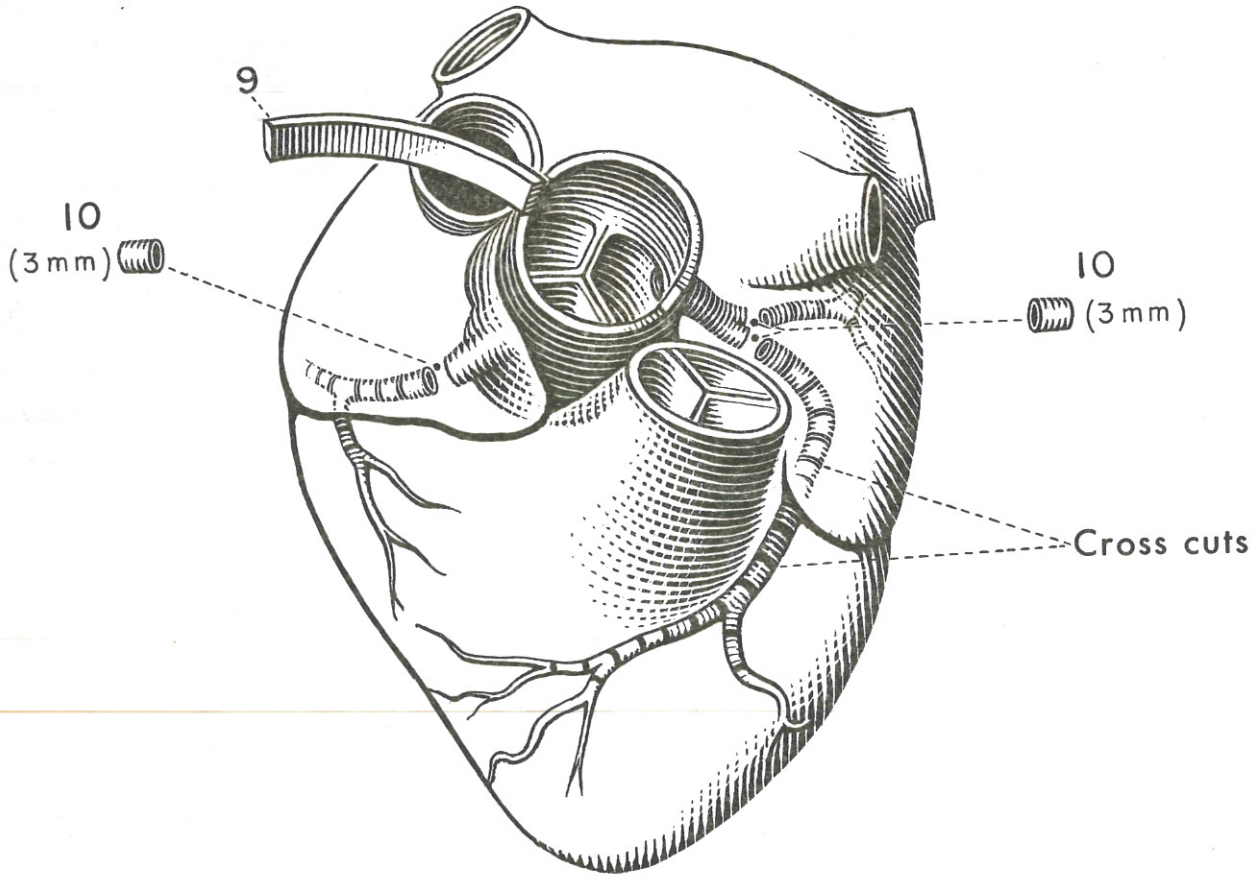

Figure 4.

tricle by cutting the wall of the right ventricle parallel to and about 1 cm. away from the ventricular septum, passing through the valve at the junction of the anterior cusps, continuing the incision to connect with the previous incision in the pulmonary artery (D, E–6, fig. 3).

d. Open the left atrium by cutting between the openings of the pulmonary veins and making another incision from the opening of the left pulmonary vein to the tip of the left auricular appendage (F–7, fig. 3). Open the left ventricle by inserting the amputation knife through the opening of the mitral valve and stabbing it through the wall of the left ventricle in the region of the apex, and incise the ventricle along its lateral border, directing the knife through the valve near the lateral junction of the aortic leaflet and posterior leaflet of the mitral valve (F–8, fig. 3). The left ventricular cavity can now be partially opened and any blood clots removed. Exend the incision to the apex of the heart.

e. Open the left ventricular outflow tract by directing the amputation knife up through the aortic leaflet of the mitral valve. Make the incision lateral to the ventricular septum, up into the root of the aorta, reflecting the previously freed pulmonary artery away from the surface of the aorta (F-9, fig. 3). Direct the knife through the aortic valve ring in the region of the commissure between anterior and left posterior valve cusps and up into the aorta.

f. Another method of opening the heart is to make a series of horizontal cuts spaced about 1 cm. apart, beginning at the apex of the heart, and continuing to the base of the papillary muscles (fig. 5). This method is useful in demonstrating involvement of the ventricular wall in cardiac hypertrophy or in myocardial infarction.

g. Another method of opening the heart is to make an incomplete horizontal cut on the posterior surface of the ventricles so that the apex of the heart can be flexed permitting examina-

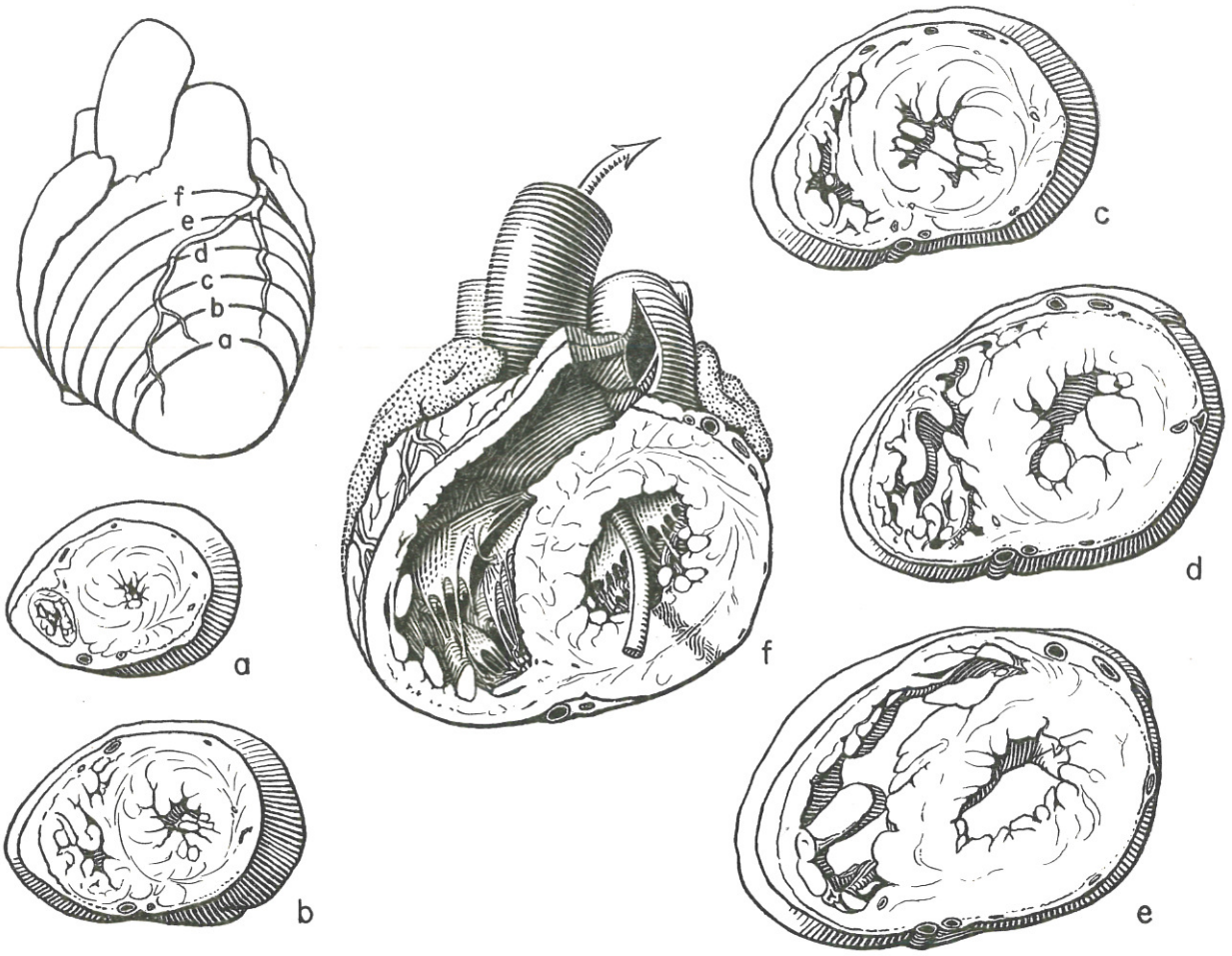

Figure 5.

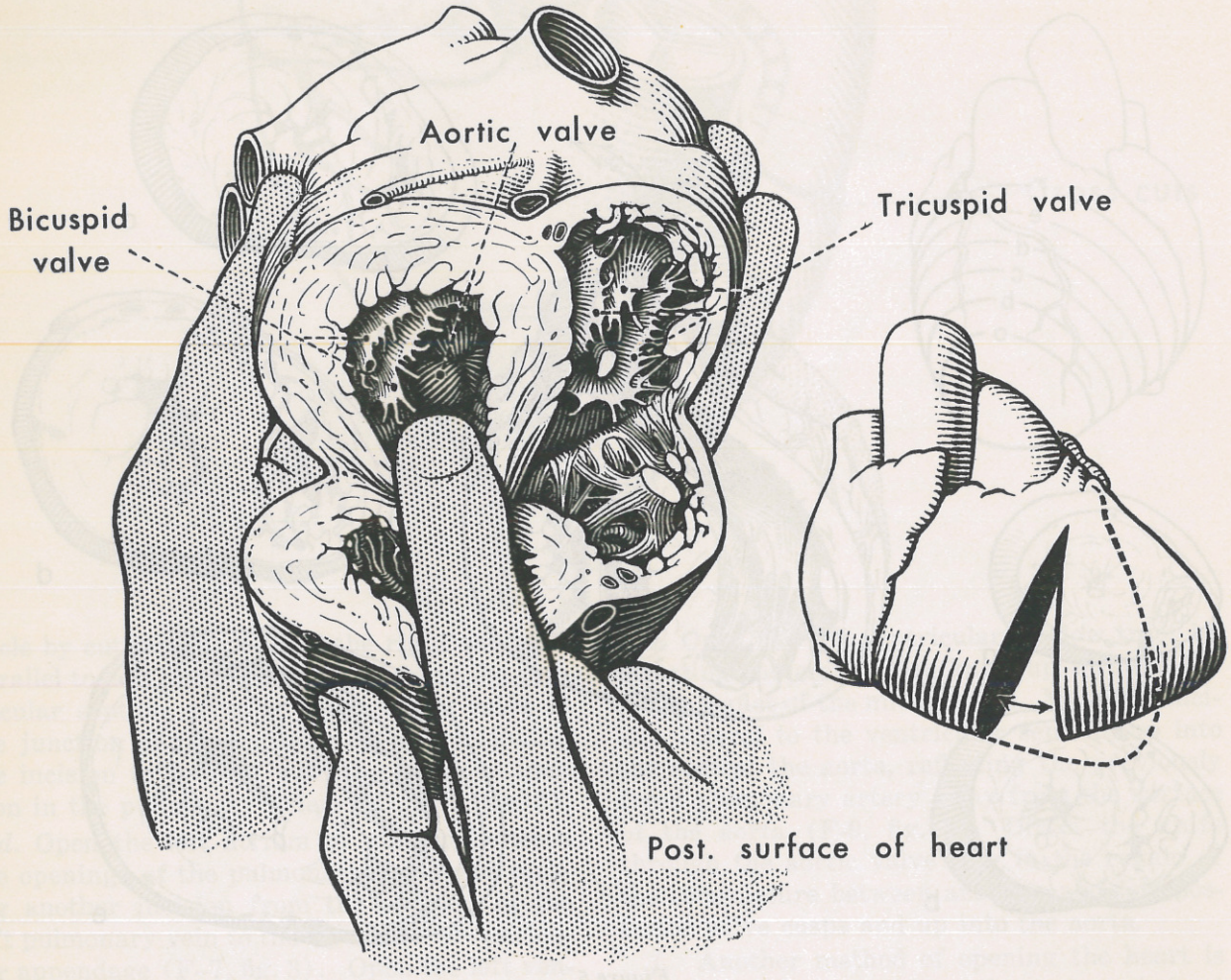
Aortic valve
Bicuspid valve
Tricuspid valve
Post. surface of heart

Figure 6.

tion of the valves from below (fig. 6). Continue the dissection as outlined in the "blood flow" method.

22. Histologic Examination

a. It is advisable (Gross et al.[1]) to take tissue for histologic examination from the following sites:

Block I: Posterior border of left atrium toward the interatrial septum, approximately 1 cm. above the insertion of the posterior leaflet of the mitral valve (1, fig. 7).

Block II: Posterior leaflet of the mitral valve. From the slot made by removal of the left atrial block cut downward toward the apex so that the blade passes through the posterior leaflet of the mitral valve and the entire thickness of the adjacent myocardium. Extend the incision about 3 mm. below the free edge of the valve. Make a parallel cut and remove the block (2, fig. 7).

Block III: Posterior papillary muscle of the left ventricle. Make a longitudinal incision with a scalpel, starting at the apex of the posterior papillary muscle and continuing down its base. Use a parallel incision to remove the block (3, fig. 7).

Block IV: Tissue from aorta, mitral valve, and interior leaflet of mitral valve. Insert a pair of scissors beneath the anterior leaflet of the mitral valve so that one blade lies against the atrial surface of the valve and the other against the posterior (noncoronary cusp) of the aortic valve. Carry the incision upward through the middle of the posterior cusp of the aortic valve and through the lower portion of the aorta. Make a parallel incision and remove the block (4, fig. 7).

Block V: Pulmonary artery and valve. Cut across the pulmonary artery about 1 cm. above the pulmonary valve. Make a second incision through the center of the anterior cusp of the pulmonary valve in the direction of the apex of the heart, cutting through the anterior cusp, the pulmonary arterial ring and down into the wall of the right ventricle. Remove the block by means of a parallel incision (5, fig. 7).

Block VI: Right atrium and right ventricle. Cut through the wall of the right atrium and septal leaflet of the tricuspid valve about 1 cm. above the septal leaflet and 5 cm. lateral to the septal anterior commissure. (The blade of the knife should emerge just below the posterior cusp of the aortic valve.) Cut downward toward the apex of the heart through the wall of the right ventricle to a point 1 cm. below the free edge of the valve. Make a parallel incision approximately 2 mm. to the left, and remove the block (6, fig. 8).

Blocks VII and VIII: The auricular appendages. Cut through the auricular appendages about 1.5 cm. from their tips. Make a parallel incision 3 mm. medial to the first and remove the blocks (7 and 8, fig. 7).

Block IX: Aorta. Cut the aorta transversely 1.5 cm. above the aortic valve for a distance of 3 cm. Make a parallel incision 3 mm. above the first and remove the block (9, fig. 4).

Block X: Coronary arteries. Blocks of tissue 3 mm. in thickness are cut from both coronary arteries about 1.5 cm. from their origin from the aortic valve (10, fig. 4).

b. When a conduction defect is suspected, histopathologic study of the AV node, the bundle of His, and the bundle branches is indicated, according to Lev, Widran, and Erickson.[2] A block of tissue is taken and divided into four parts as illustrated in figure 8. See reference for details.

c. The circumference of all four valves and the width of the ventricles are measured. When a valve is stenosed the transverse diameter of the ostium is measured. See appendix III, table I for normal weights and measurements.

[1] Gross, L.; Antopol, W.; and Sacks, B.: A standardized procedure suggested for microscopic studies on the heart with observations on rheumatic hearts. Arch. Path. 10:840–852, 1930.

[2] Lev, M.; Widran, J.; and Erickson, E. E.: A Method for the Histopathologic Study of the Atrioventricular Node, Bundle, and Branches. Arch. Path. 52:73–83, 1951.

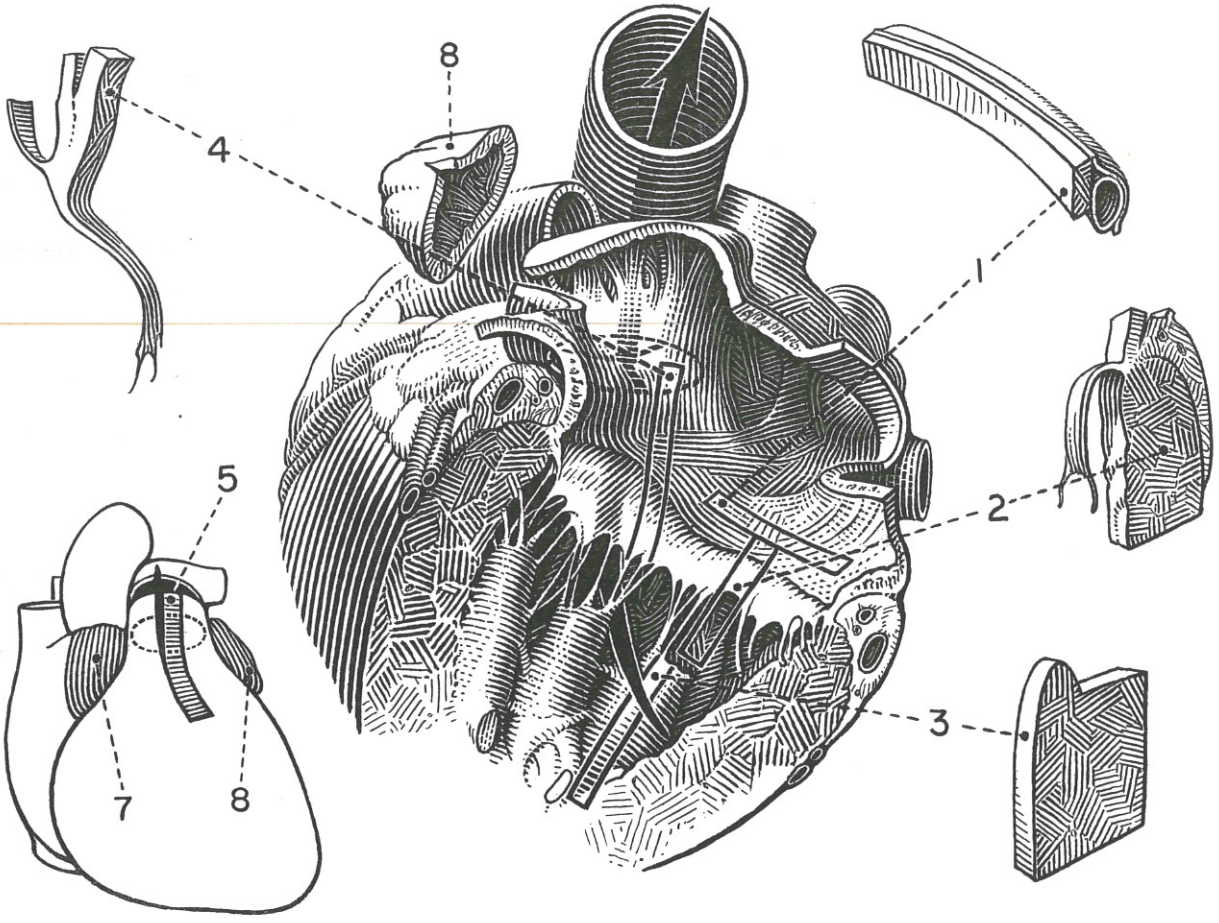

Figure 7.

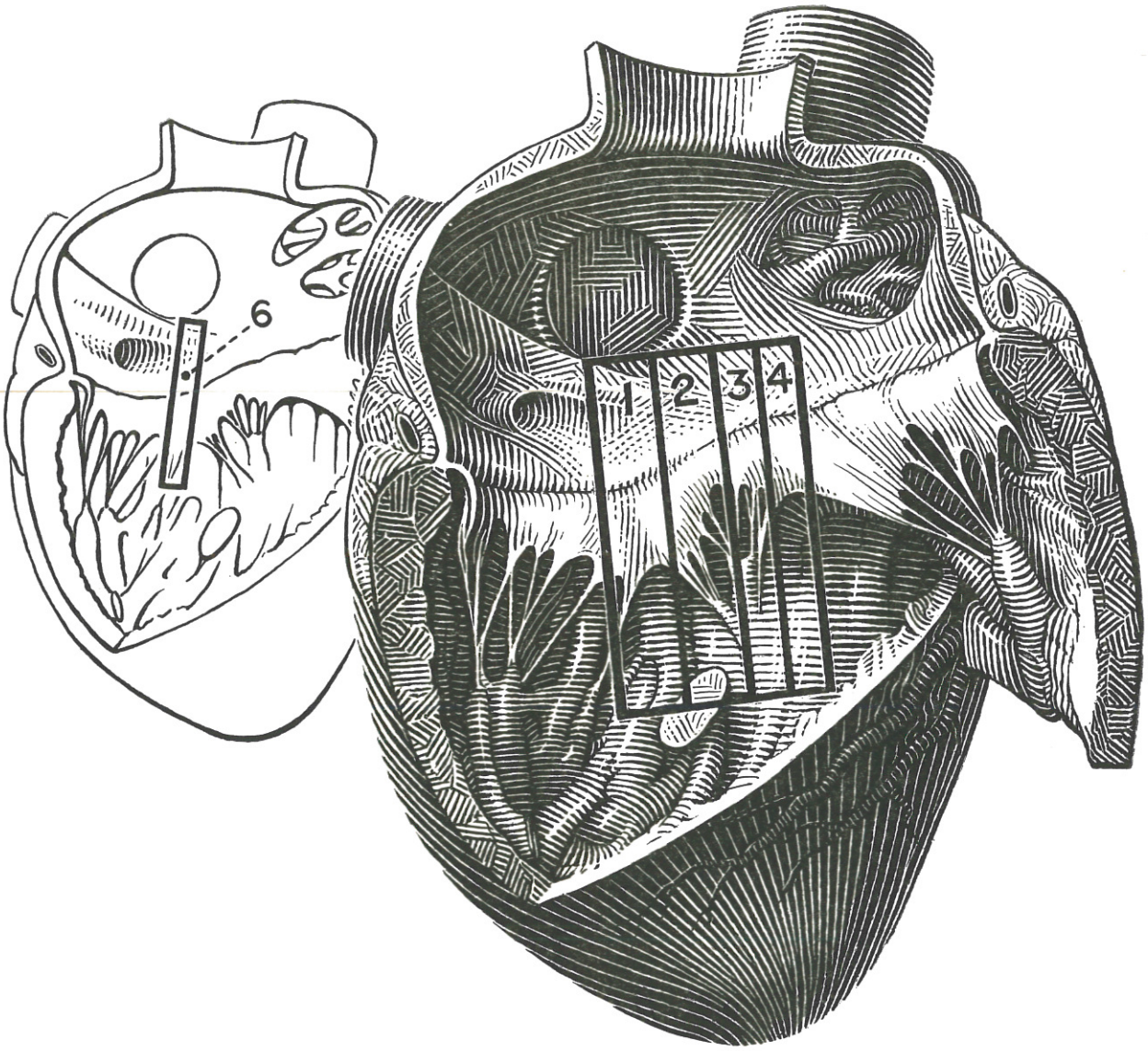

Figure 8.

23. Procedures for Certain Cardiac Conditions

a. In congenital heart disease it is preferable to leave the lungs attached to the heart since proper examination is time consuming and is best done after completion of the autopsy. The heart is dissected, unfixed according to the "blood flow" method; the entire specimen is then placed in 10 percent formalin for more detailed study after fixation.

b. When a pulmonary arterial embolus is found, its original site should be searched for in the right atrium and auricular appendage, the femoral and iliac veins, the veins of the upper and lower extremities, and the pelvic veins.

c. Air embolism in the heart can be demonstrated only at the time of autopsy, and a different method of opening the heart and great vessels is required.

(1) Venous air embolism may be associated with tubal patency test, pneumothorax, pneumoperitoneum, pneumoencephalography, intravenous infusion, childbirth, or operations on neck and thorax. A large amount of air (100 to 150 cc.) is required to cause death; arterial air embolism to the left side of the heart from tears in the lungs or pulmonary veins requires less. Air trapped in the left side of the heart may be embolic to the coronary or cerebral vessels.

(2) Expose the sternum and costal cartilages by a simple midline incision from just below the sternal notch to the symphygis pubis. This incision prevents introduction of air into the heart from severed superficial neck veins. Reflect the skin and muscles. Cut the rib cartilages laterally through the level of the second rib. Do not incise the sternoclavicular joint. Sever the diaphragm from the sternum. Lift up the sternum and break it to expose the pericardium. Ligate the aorta tightly proximal to the origin of the great vessels. Lift the pericardium from the surface of the heart and incise its anterior surface for a distance of 3 cm. Elevate the edges of the incision with forceps and inspect the contents, parietal pericardium and epicardium. In cases of fatal air embolism the right side of the heart may have a balloon-like appearance. Take cultures of the fluid in the pericardial sac to rule out post-mortem gaseous decomposition and clostridial infections which may simulate air embolism.

(3) Fill the pericardial sac with water and submerge the heart. Make a single superficial cut across the left circumflex coronary artery and the descending branch of the left coronary artery; take care not to enter the chambers of the heart. "Milk" the left coronary arteries with the finger toward the incision; this allows air bubbles, if present, to be detected in the water. Repeat the procedure with the right coronary artery. Incise under water the right atrium, right ventricle and pulmonary artery, and exert slight pressure to release trapped pockets of air. Examine the left atrium, left ventricle, the superior vena cava, the inferior vena cava, and the pelvic veins in a similar manner.

(4) Air embolism may be differentiated from gaseous decomposition by placing air from the heart into a bottle containing alkaline two percent pyrogallol solution (Gradwohl[3]). Oxygen containing air stains this solution brown; gases of decomposition causes no change in color. A practical device for demonstrating air embolism has been devised by Kulka[4].

24. Trachea and Bronchi

a. Dissect remnants of the pericardial sac from the underlying structures to expose the trachea and main bronchi. Ordinarily the trachea is transected just below the larynx and is removed along both lungs. Open the trachea and bronchi with scissors by cutting through the posterior walls. The character of the mucosa and the presence of fluid, mucus, and foreign bodies should be noted.

[3] Gradwohl, R. B. H.: Legal Medicine. C. V. Mosby Co., St. Louis, Mo., p. 150, 1954.

[4] Kulka, W.: A practical device for demonstrating air embolism. Arch. Path. 48:366–369, 1949.

b. In special cases, such as death due to drowning or aspiration of foreign bodies, or when bronchogenic carcinoma is present, the trachea and main bronchi should be opened *in situ* by cutting the anterior walls with a scalpel or scissors.

25. Lungs

Divide all structures at the hilum of each lung, noting the contents of the lumens of the bronchi, pulmonary arteries, and pulmonary veins as they are cut. The internal structure of the lung is best exposed by a single incision along the long axis of each lung, extending from the most lateral convexity toward the hilum. This incision should be so placed as to expose the maximal surface of each of the lobes of the lungs. Any further incisions should be made parallel to the primary incision. Open the major bronchi with scissors. Expose and examine the lymph nodes at the hilum. Examine the principal branches of the pulmonary artery and vein on the cut surface of the lung for thrombi and emboli, and open them further if necessary. Weigh each lung and select representative blocks for microscopic study. Blocks from the various lobes may be cut in distinctive shapes so as to indicate the origin of each.

26. Examination of the Larynx, Pharynx, Hypopharynx, Tongue, Thyroid, and Parathyroid

a. When there is extensive disease of these structures it is advantageous to remove all the neck organs as a unit. To accomplish this, the skin, together with the attached platysma muscle and portions of the pectoral muscles, is dissected from the underlying tissue and retracted as far superiorly as possible. The muscles of the neck will be exposed and enlarged cervical lymph nodes can be noted. Further dissection will reveal the submaxillary glands in the submaxillary triangles. The thyroid gland is brought into view by dissection and lateral retraction of the infrahyoid muscles. With blunt dissection each common carotid artery is dissected from the carotid sheath and retracted away from the larynx and trachea along its entire course in the neck. Avoid cutting the carotid arteries during this procedure because of their importance to proper embalming of the head. These vessels are ligated with long strings and then severed at their origins from the aortic arch on the left and the innominate artery on the right. The patency of the internal carotid arteries can be tested by injecting them with physiological solution of sodium chloride after the brain has been removed.

b. The extrinsic muscles of the tongue are cut through their attachment to the mandible and styloid process with the amputating knife. The stylopharyngeus muscle is severed from the styloid process at the same time. The soft palate and uvulva are cut from their attachments. The mobilized tongue is drawn inferiorly and the posterior wall of the pharynx and esophagus separated from the underlying tissues. The lower respiratory tract, including the trachea, bronchi, and lungs, may be left attached to the upper air passage or the trachea, while the proximal portion of the esophagus may be transected. In this way the tongue, the pharynx, the pharyngeal muscles, the larynx, the trachea, the thyroid, the parathyroids, and the proximal portion of the esophagus are removed *en bloc.* After examination of the surface of the tongue, multiple transverse sections are made.

c. Dissection of the parathyroid glands is facilitated by removal of the new structures *en bloc* so that there will be landmarks. The parathyroids are sought from the posterior aspect. The prosector is more likely to find all parathyroid glands if he is seated and has a spotlight directed on the field. Some pathologists prefer to fix the specimen in formalin before attempting to locate the parathyroid glands, because they are firmer and a deeper yellowish brown than in the fresh state. The upper parathyroid glands as usually found embedded in the deep cervical fascia between the esophagus and the posterior aspect of the upper portions of the lateral lobes of the thyroid. The lower parathyroids are usually found in the deep cervical fascia along the inferolateral aspect of the lateral lobes of the thyroid. Occasionally the parathyroids may be embedded in the thyroid gland. The normal parathyroid glands are yellow-brown vascular structures that are distinct in color and consistency from the surrounding softer yellow fat and firmer gray lymph nodes. In cases in which the parathyroid glands are of unusual interest, all the tissue from this region should be saved for microscopic examination in the event that all the glands are not iden-

tified grossly. After the parathyroid glands are removed, the thyroid gland is dissected from the larynx and multiple sections are made through it.

d. The upper air passage should be examined for evidence of obstruction before it is opened. Next, the hypopharynx, including the epiglottis and the pyriform sinuses, should be examined. The upper portion of the esophagus is opened posteriorly and dissected away from the posterior wall of the larynx. The larynx is then opened longitudinally along its posterior aspect to reveal the vocal cords.

27. Mesentery and Intestine

a. Excise the greater omentum close to its attachment to the stomach. The superior mesenteric artery and vein can be examined when the transverse colon and its mesentery are drawn superiorly. By this maneuver the root of the mesentery and its vessels will usually be exposed. In an obese subject it will be necessary to remove fat to bring the vessels to view. Open the vein and the artery. Examine the mesentery by multiple sections across the mesenteric arteries, veins, and lymph nodes. Tie the jejunum with double ligatures for a few centimeters below the ligament of Treitz. Use a sharp, long knife to separate the intestine from the mesentery as close as possible to the intestine. On reaching the ileocecal region, incise the peritoneum of the posterior abdominal wall and lift the cecum and ascending colon free from the surrounding tissues. Separate the transverse colon from its attachments to the stomach, and raise the descending colon away from the posterior abdominal wall. Displace feces from the sigmoid and rectum by stripping upward into the descending colon. Place double ligatures about the sigmoid colon 5 to 6 cm. above the sigmoidorectal junction. Cut between the double ligatures around the jejunum and colon and lift the entire intestine from the body.

b. The rectum is removed along with the bladder as indicated in figure 9 and described under *Urinary Tract.*

c. Remove the mesentery of the small intestine by severing its attachment to the posterior abdominal wall. Open the small intestine with blunt scissors or enterotome along the mesenteric attachment, and the large intestine along one of the taenia. The appendix may be examined by multiple cross sections or by a longitudinal incision through the lumen. As the intestine is opened, note the fluidity, color, and other characteristics of its contents. Take sections of representative regions. Do not rub the fingers over the mucosa or wash it with water before the sections are placed in fixative. Record the thickness, consistency, and color of the mucosa and of the wall as a whole.

28. Spleen

Examine the anterior surface of the pancreas, the splenic artery, the vein on the superior surface of the body and tail of the pancreas. Lift the spleen, divide the vessels at the hilum, and remove the spleen. Weigh the organ and measure its length, breadth, and thickness. Expose the parenchyma by a single incision extending from the greatest convexity toward the hilum. Further incisions should parallel the first. Fix a representative block from the organ, including the capsule.

29. Gallbladder, Ducts, and Porta Hepatis

Open the first and second portions of the duodenum by an incision on the anterior surface. Locate the major and minor duodenal papillae. Exert pressure on the gallbladder and note whether bile streams from the major papilla. Divide the peritoneal covering on the lateral walls of the duodenum and expose the lower part of the common bile duct. With a scalpel open the duct, and with scissors extend the incision upward into the hepatic ducts and the cystic duct, and downward into the ampulla. Note the character of the bile in the ducts and inspect for calculi. Open the gallbladder longitudinally with scissors and collect the bile in a clean dry glass container, or the gallbladder may be dissected intact from its bed after removal of the liver, and then opened. Inspect the bile for concrements and examine the mucosa and wall of the gallbladder. Open the portal vein and the splenic veins. Examine the hepatic artery.

30. Esophagus, Stomach, and Duodenum

If there is no pathologic change to indicate the desirability of keeping the liver, bile ducts, and duodenum in one piece, cut across the structures in the hepatoduodenal ligament and remove the duodenum, pancreas, stomach, and

esophagus *in toto*. Extend the previous incision in the anterior surface of the first part of the duodenum along the greater curvature of the stomach and up the anterior wall of the esophagus. Note the character of the stomach contents, the thickness, rugae of the mucosa, and other features of the walls. Extend the incision in the second part of the duodenum so as to open the entire length of the third part.

31. Pancreas

Examine the pancreas by making multiple cross sections or by a single frontal section extending from the inferior border to the superior border. On the cut surface locate the pancreatic duct; note its size and content, and the character of its wall. With small sharp-pointed scissors open the pancreatic duct. Separate the pancreas from the duodenum by dissection. Weigh it and measure the long axis, the width of the head, and the average depth. Select blocks of the head, body, and tail for microscopic study. The islands are most numerous in the tail. This block should be used for routine sections.

32. Liver

Remove the liver by division of the triangular ligaments and the hepatic veins as they join the inferior vena cava at the lower border of the diaphragm. Weigh the liver and measure its three principal axes. The first incision in the liver should extend on the long axis and be directed from the greater convexity toward the porta hepatis. Further incisions should be parallel to the first. Place representative blocks, including the capsule, in fixative.

33. Adrenal Glands

Free the adrenal glands by dissection and remove extraneous tissue. Weigh the organs if the size is abnormal and examine the cut surface by making parallel sections. Place a part or all of each organ in 10 percent formalin.

34. Aorta and Vena Cava

a. Use an enterotome to open the aorta along the anterior surface. Inspect the intima, the wall, and the orifices of each of the principal branches. The orifices should be opened. If there is no pathologic change in the renal arteries or renal veins, they may be divided at a point 1 cm. from the aortic orifice. If the arch of the aorta is to be removed, the 3 major branches (innominate, left common carotid, and left subclavian arteries) must be ligated about 2 cm. above their origins and severed below the ligatures which should be left with ends at least 5 inches long for the use of embalmers.

b. Open the inferior vena cava from the bifurcation of the iliac veins to the level of the diaphragm.

35. Urinary Tract

Remove urine from the bladder with a syringe and needle if indicated. With a finger or blunt instrument separate the bladder from the extraperitoneal tissues of the retrosymphysial space so that the bladder and prostate are completely free from the pelvic wall. Further dissection with the fingers posteriorly will separate the rectum from the body wall. A knife or curved scissors may be used to cut the urethra distal to the prostate and the rectum not less than 2 cm. above the anorectal junction. Reflect the pelvic organs upward and outward, exposing the great iliac vessels. Free the kidneys and ureters by retracting them toward the midline from surrounding structures and remove them by a sharp dissection along with the bladder, internal genitalia, and rectum from the body in one block (fig. 9).

36. Kidneys

With a long knife divide the kidney into anterior and posterior halves by a straight,

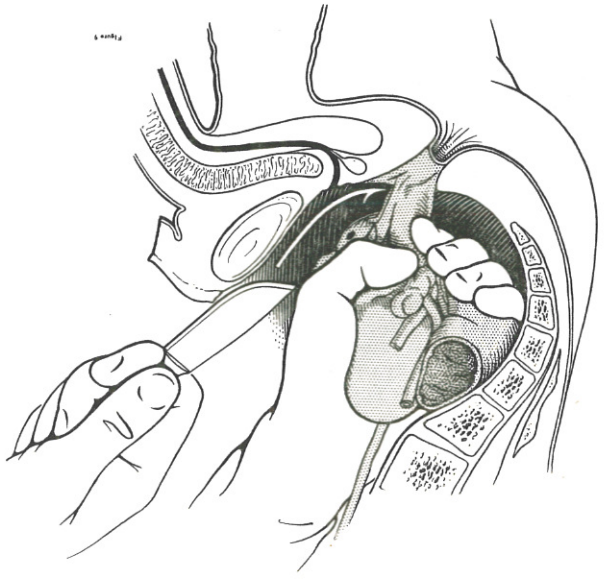

Figure 9.

sharp, single incision along the longitudinal axis of the convexity, as indicated in figure 10. With scissors open the pelves and the ureters, the renal artery and vein and their major branches. Record the weight, length, breadth, and depth of each kidney after severing the ureter. Strip the capsule to expose the surface of the parenchyma. For histologic study remove a block of tissue 3 to 5 mm. thick, including cortex, medulla, and pelvic mucous membrane from each kidney as shown in figure 11. Measure the thickness of the cortex and the thickness of the entire renal substance.

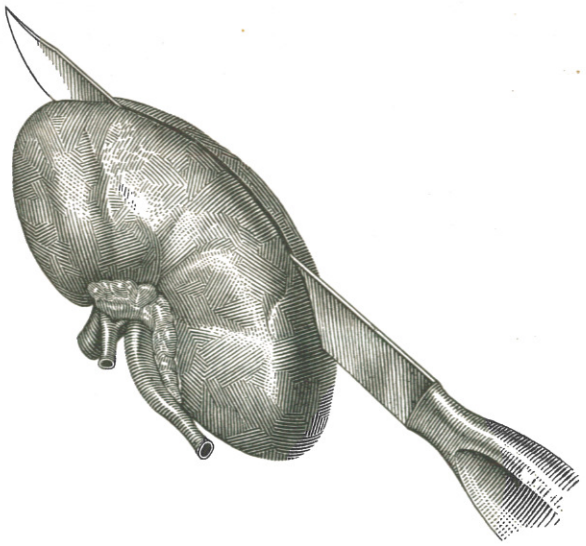

Figure 10.

37. Urinary Bladder

Open the bladder by a vertical incision on the anterior surface extending from the fundus to within a few millimeters of the internal urethral orifice. Invert and inspect the mucosa and wall. Select a block to include all layers of the wall for fixation.

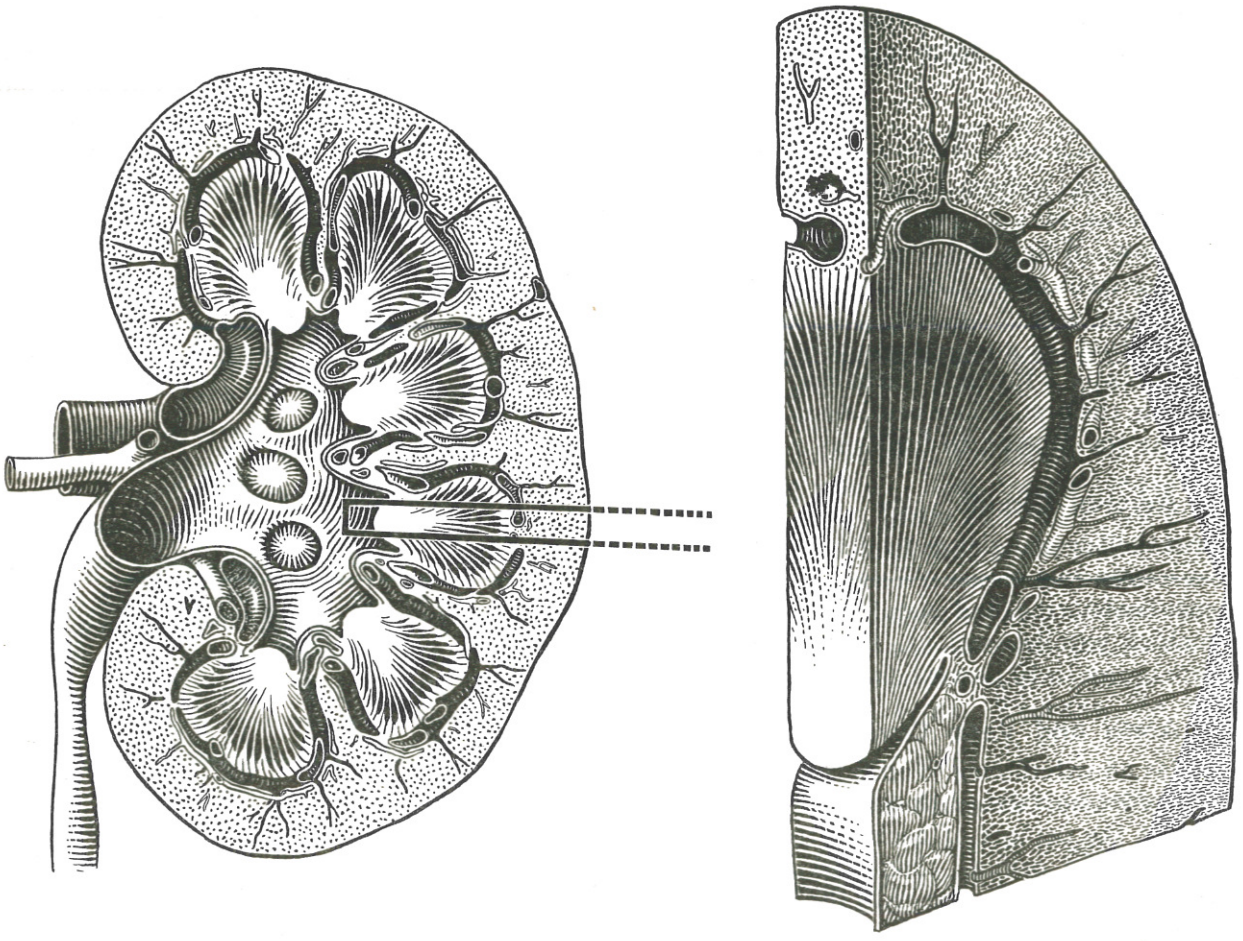

Figure 11.

38. Prostate

The prostate is examined by multiple coronal sections 5 to 6 mm. apart, extending from the base of the bladder to the apex of the prostate. Inspect the mucosa of the urethra. Place one complete coronal block, including the posterior lobe, in fixative.

39. Rectum and Sigmoid

Open the rectum with an enterotome along the posterior midline. Remove fecal material and examine the mucosa and wall. Dissect the rectum from the posterior wall of the bladder and from the prostate to display the seminal vesicles in men. In women dissect the rectum from the vagina.

40. Seminal Vesicles

Multiple longitudinal incisions, 2 to 3 mm. apart, serve to expose the wall and the lumens of the vesicles. The thickness, the character of the wall, and the physical characteristics of the seminal fluid should be noted. Place a representative block in fixative.

41. Testes and Epididymides

a. Remove the testes by enlarging the inguinal canal, inverting the scrotum, and cutting the attachment of the tunica vaginalis to subcutaneous tissue of the lower part of the scrotum. If there are related pathologic changes in the genital tract, the testes should be mobilized before the pelvic organs are removed, so that the entire length of the vasa and the attachment to both the epididymides and the seminal vesicles are preserved.

b. Open the tunica vaginalis and note the amount and physical characteristics of the fluid it contains. Incise testes and epididymes. If abnormality exists, record the weight and measurements. Observe the thickness of the tunica, the tissues of the epididymis, and the consistency of the testis. With forceps determine the ease with which the tubules "string" from the cut surface of the testis. Place a block from the opposite half in fixative.

42. Vas Deferens

Examine the vas deferens by multiple cross sections without completely dividing the structure. Note the size and richness of the pampiniform plexus and inspect for thrombi.

43. Examination of the Female Genitalia and Breasts

a. In autopsies of women the internal female genitalia are removed with the bladder and the rectum. Examine the bladder and separate it from the anterior surface of the vagina. Open the vagina with scissors or knife along the anterior midline. With a knife open the uterus along the anterior midline from the cervix to the top of the fundus. The cornua may be opened by incisions in the anterior wall at right angles to the primary incision. An alternative method of opening the vagina is to incise each lateral wall with knife or scissors. The incisions can be carried superiorly through the cervix and lateral walls of the uterus to the cornua, which exposes a larger portion of the endometrium for inspection. Record the thickness of the endometrium and myometrium, and the greatest length, breadth, and depth of the uterus. Examine the fallopian tubes by multiple cross sections. Open each ovary by a single incision to expose the largest surface. Inspect the veins and arteries in the broad ligament. Fix blocks from the vagina, cervix, uterus, tubes and ovaries.

b. The mammary glands are conveniently examined after reflection of the skin and subcutaneous tissues over the thorax. Multiple sections from the posterior aspect extending to within a few millimeters of the skin will expose the mammary tissues. If the nipple is diseased it may be removed.

44. Removal and Examination of the Brain

a. When bacteriologic or viral studies of brain tissue are indicated by clinical history or gross appearances, the brain should be removed prior to embalming. For special directions concerning microbiological studies see paragraphs 90 through 102.

b. After examination of the scalp, an intermastoidal incision extending over the vertex of the skull is made with the blade of the scalpel turned outward to prevent cutting the hair (fig. 12). If the subject is bald, the incision should be placed as far posteriorly as possible and may sometimes be hidden by making the incision backward from points about 2 inches above the ear to encircle the scalp posteriorly within the hairline. It is advisable to start the incision behind the right ear and end it behind the left, so

that if disfigurement occurs, it will be on the left side of the head. Embalmers regard the right side of the face as the "show" side. Reflect the scalp anteriorly to a line 1.5 cm. above the supra-orbital ridge and posteriorly below the occiput. With a sharp instrument mark out the anterior saw cut from behind the ears over the frontal bone and, whenever possible, posterior to the hairline (fig. 13). The posterior cut should extend backward from the lower end of the anterior cut over the occipital bone to the midline at the level of the superior nuchal line, where it should meet with the posterior cut from the other side. The angle formed by the anterior and posterior skull incisions should be from 100° to 120° and should be so placed that neither limb, if extended, will intersect the external ear. This is of practical importance in protecting the ear from the saw. Use a scalpel to cut the temporal muscle and fascia along the plotted lines, and with a blunt instrument separate the tissues from the bone along the incision. Cut the entire thickness of the skull with a fine tooth saw or Stryker saw but do not allow the saw to slip into the brain. If there is a question of possible skull fracture, do not use hammer and chisel in removing the calvaria, as these implements may create fracture lines that will complicate medicolegal cases. Remove the calvaria, separating it from the underlying dura by blunt dissection between bone and dura. Open the superior longitudinal sinus. Cut the dura with scissors along the edges of the bone and reflect it toward the midline. Use scissors to cut the falx cerebri anteriorly in the great cerebral fissue and pull the dura posteriorly, cutting the cerebral veins as necessary and the great cerebral vein of Galen in the pineal fossa. With the left hand lift the frontal lobes and olfactory nerves from the floor of the anterior fossa and use scissors to cut the optic nerves that can be reached. Place the left hand beneath the parietal lobes to support the weight of the brain and cut the tentorium cerebelli on each side beneath and close to its peripheral attachments. The posterior cranial fossa is exposed and the remaining cranial nerves and the vertebral arteries can be severed. Support the brain carefully with slight traction on the cerebral peduncles and transect the cervical cord as far inferiorly as possible. Remove the brain by lifting it with the fingers of both hands to prevent damage to the soft organ.

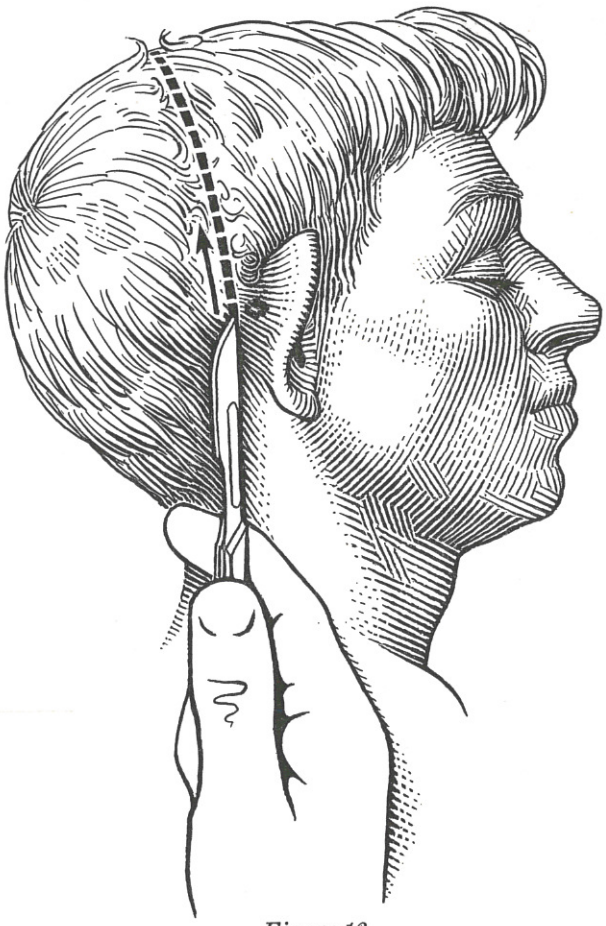

Figure 12.

c. After removal, fix the brain and spinal cord in 10 percent formalin. Before the brain is placed in fixative, the corpus callosum may be incised sagittally on each side of the midline to permit access of fluid to the ventricles. Suspend the brain in a gallon jar or fixative by a string passing under the basilar artery and attached to the edges of the container. The brain should be allowed to harden in fixative for at least one week, preferably two weeks, before sectioning. The fixing fluid should be changed during the first 24 hours and at the end of one week. If immediate diagnosis is necessary, the brain may be cut in the fresh state. This procedure is expedited if the freshly sectioned surface is pressed firmly against a piece of glass before the next cut is made, and the knife blade is flooded with 95 percent alcohol. If desired, the intact fixed brain may be forwarded to the Armed Forces Institute of Pathology.

d. When the brain has hardened in fixative it should be cut in coronal sections not more than 1 cm. in thickness. Place the brain on a dissect-

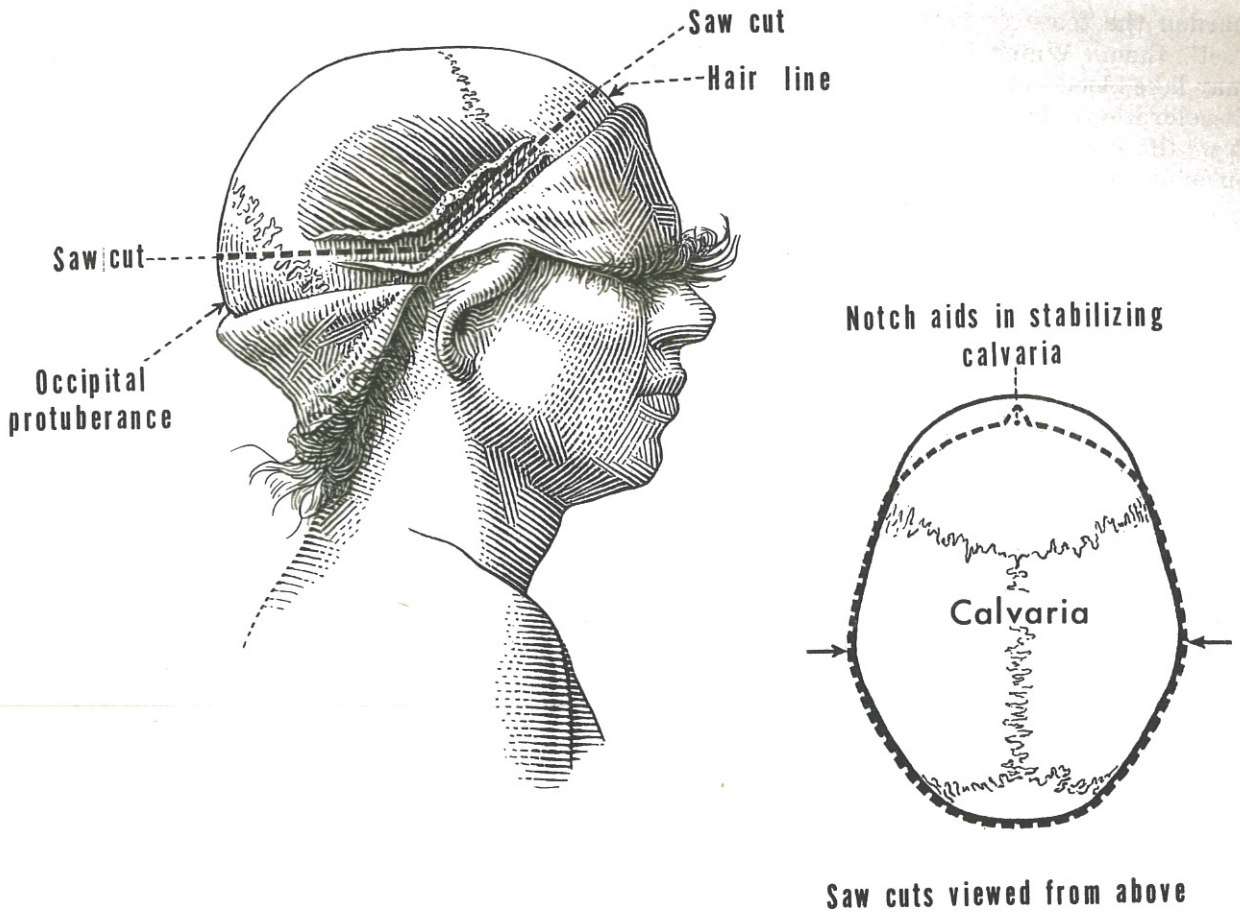

Figure 13.

ing board with the ventral surface upward so that the landmarks of the base can be used in orienting the coronal cuts symmetrically. Remove the brain stem and cerebellum with a thin knife, cutting across the cerebral peduncles in a plane perpendicular to the axis of the brain stem and aqueduct. Begin the parallel coronal sections of the cerebral hemispheres at the frontal poles. The brain stem and cerebellum together are cut by parallel sections 0.5 cm. apart in a plane perpendicular to the axis of the brain stem.

45. Examination of the Base of the Skull

a. Fractures of the Base. For demonstration of fractures the dura should be stripped from the bone. This is best done by winding it onto a hemostat attached to the cut edge of the dura. Some pathologists prefer to use "gas pliers". In either case the dura should be stripped immediately after the brain is removed and before chisel and hammer are used, since they may cause fractures.

b. Pituitary Gland. The posterior clinoid processes are broken with a chisel directed toward the occiput. The diaphragm of the sella is incised around its periphery and the pituitary gland is removed by sharp dissection. The entire gland is fixed in 10 percent formalin. Later it may be sectioned either horizontally, which exposes the topographic features of the anterior lobe, or saggitally, which better demonstrates the stalk and intermediate lobe.

c. Dural Sinuses, Carotid Arteries, and Gasserian Ganglia. The dural sinuses, notably the cavernous, superior and inferior petrosal, saggital and sigmoidal, are opened with curved scissors. The carotid arteries may be traced through the walls of the cavernous sinus and in their canals by use of heavy scissors and a narrow chisel. If there is history of cerebral dysfunction, the patency of the carotids should be tested by slowly injecting saline solution into the common carotids and observing its flow out of the intracranial ends of the internal carotids. Formalin should not be used, because it might

harden the features before the embalmer can "set" them. Water is inadvisable, because it may lake blood in the tissue and produce foci of discoloration. Remove the gasserian ganglia from the subdural pockets lateral to the cavernous sinus and place in 10 percent formalin.

d. Temporal Bone and Middle Ear.[5]

(1) To remove the temporal bone in one piece, make four primary cuts in the bone with a motor driven circular saw, or a Stryker cast cutter with a one to two inch blade. If neither of these instruments is available, a thin-bladed osteotome or a chisel and light hammer can be used. The dura should be left attached and care should be taken to remove the temporal bone in such a manner that the external contour of the head is maintained.

(2) See figure 14 for incisions. The *first* incision is placed as close as possible to the inner surface of the squamous portion of the temporal bone and directed slightly lateralward so as to include the ear drum. The *second* incision is roughly parallel to the first and medial to the inner lip of the internal auditory meatus. The *third* incision is made about 2.5 cm. anterior to the petrous ridge. It is most important that the lateral end of this third incision be deep and connect with the first. The *fourth* incision is an undercut at the line of the inferior petrosal sinus. After the initial incisions have been made the specimen is loosened further by using a short thin-bladed osteotome in the corners and on the styloid process. When the specimen can be lifted, the attached soft tissues are severed with strong, curved scissors. When disease of the eustachian tube is suspected, the third and fourth incisions can be extended to include the sella turcica and the upper part of the nasopharynx in the block with the temporal bone. The base of the skull is weakened by removal of these bones; therefore, the fragile bridge of the temporal bones remaining laterally must be handled gently and the entire base of the skull filled with plaster of Paris to fix the anterior and posterior halves together before the calvaria is replaced.

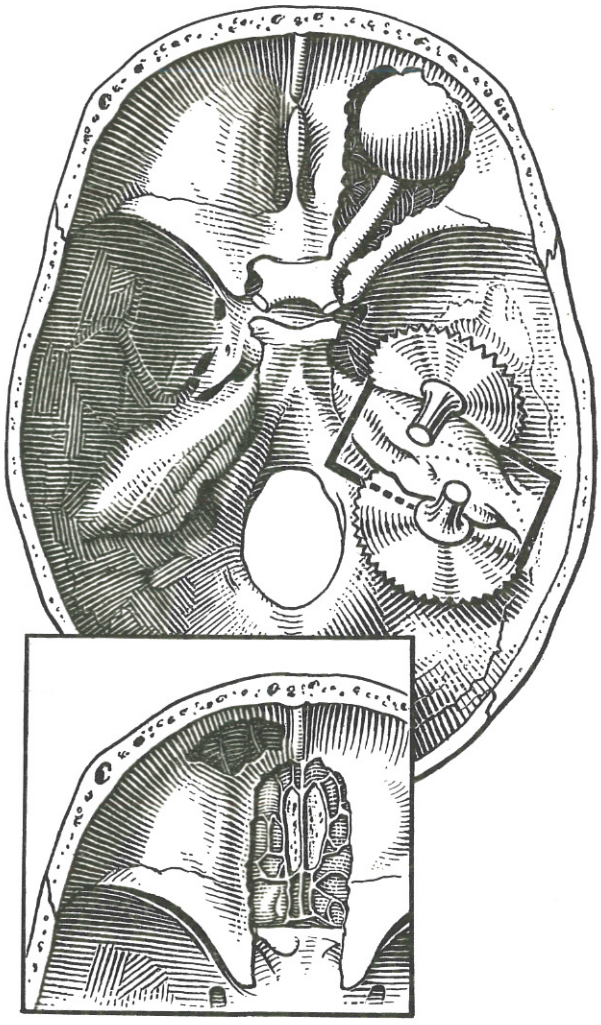

Figure 14.

(3) The temporal bone should be placed immediately in 500 cc. of 10 percent formalin and the fluid changed daily for 3 days before shipment.

e. Eyes.

(1) Either the entire eye or the posterior half of the globe may be obtained from within the cranial cavity (*special permission required*). After removing the brain and pituitary, unroof the orbit and expose the optic nerve and eyeball (fig. 14). Make traction on the extra-

[5] Fowler, E. P., Jr.: Proc. Am. Acad. Ophth. and Otolarying. Vol. 60, p. 732, Sept-Act., 1956 or Medicine of the Ear (app.), Baltimore, Williams & Wilkins, 1947.

ocular muscles during the dissection to avoid crushing the nerve and eyeball. If the entire globe is removed, caution must be observed to avoid damage to the lids. Dissect the bulbar conjunctiva away from the globe, keeping the knife close to the corneoscleral limbus. The embalmer must be advised to suture the lids and restore the orbit.

(2) Fix the eye and attached optic nerve in 300 to 500 cc. neutral 10 percent formalin. It is not necessary to open the globe since aqueous formalin will penetrate the sclera and effect good fixation of the retina. After fixation, the eye should be opened with a double-edged razor blade in a horizontal plane so that the macula may be sectioned in line with the optic nerve and pupil.

f. Paranasal Sinuses.

(1) The bony plates separating the cranial cavity from the frontal, ethmoidal, and sphenoidal sinuses may be removed by means of a chisel, and the mucosa and cavities of these structures examined (fig. 14). The posterior nasopharnyx and even the maxillary sinuses can be approached by a coronal incision just anterior to the sella turcica. This is followed by posterior reflection of the clivus after it has been freed by a horizontal incision above the foramen magnum and lateral incisions through the apices of the petrous processes of the temporal bones. This procedure should be used with care, for it may cause collapse of the head and face, particularly if the temporal bones have been removed.

(2) After all required structures have been removed from the cranium, ligation of the carotid and vertebral arteries will prevent seepage of embalming fluid. Since the stumps of the terminal portions of the internal carotid arteries are frequently too short for satisfactory ligation, the dura covering the trigeminal ganglion lateral to the sella turcica is avulsed, thus uncovering the sigmoid portion of the internal carotid arteries. The skin flaps of the scalp should be restored to their natural positions to avoid creasing of the forehead.

46. Cisternal Puncture

a. The head is placed in a true lateral position and flexed maximally. Stabilize this position. The needle must be inserted just above the spine of the second vertebra, held at that point by the thumb, and then directed upward in the midline, using the top of the auricle (external ear) as a guide. The needle will usually touch the occiput, but by repeatedly withdrawing it slightly and depressing the point a little at a time it will enter the cisterna magna at such an angle that there is a distance of 2 to 3 cm. between the site of entry and the medulla. The distance from the skin to the cisterna varies, but in adults it is usually 4 to 5 cm. and *seldom* over 6 cm.

b. In some cases it may be more convenient to remove fluid by spinal puncture in the conventional manner.

47. Removal and Examination of the Spinal Cord

a. Approach. The spinal cord can be removed from the posterior or anterior approach. The posterior approach allows complete exposure of the spinal cord *in situ,* the spinal canal, the intervertebral foramina, and the roots and ganglia of the spinal nerves. The anterior route is less laborious, does not require an additional skin incision, and gives easier and more satisfactory exposure of the lumbar cord and cauda equina but usually does not permit one to obtain the dura mater or nerve roots above the tenth thoracic vertebra.

b. Posterior Removal. The body is placed prone on the table, with a block beneath the thorax to arch the thoracic spine. The head is placed over the edge of the table with the face protected by a sponge or towel from deforming pressure. A skin incision is made in the midline from the base of the skull to the sacrum; the paraspinal muscles are retracted laterally and the spinous processes and laminae scraped clean of muscle and fascia. The laminae, close to the spinous processes are cut with single or double bladed saw or with a specially devised chisel. If they are not entirely cut through, use a hammer and chisel to complete the separation. The spinous processes and adjacent laminae are removed en masse. A laminectomy should not be

done on the first cervical vertebra as it will destroy the rigidity of the connection between the head and the trunk. The spinal cord encased in its dura mater is removed by cutting the spinal nerves lateral to the posterior root ganglia and freeing the epidural tissue by sharp dissection. The cord may be damaged if it is pulled or bent to free it from the spinal canal. A better method is to make traction in the line of the longitudinal axis of the cord by grasping the dura with forceps and exerting gentle force inferiorly. The dura is opened with scissors along the posterior or anterior midline and the cord is fixed by suspending it in a tall jar of 10 percent formalin, or by pinning the opened dura to a strip of wood in a long narrow covered dish (catheter tray) containing 10 percent formalin. Examination of the cord is made by means of multiple cross sections. Blocks for microscopic study are taken at appropriate levels.

c. Anterior Removal. (Method of Kernohan) Following removal of the brain the upper cervical nerve roots are cut intradurally with a long narrow bladed knife as far inferiorly as possible. After the viscera have been removed from the thorax and abdomen, the bodies of the vertebrae are freed from the attachments of the psoas muscle and ligaments. The vertebral column is cut longitudinally with a round-end saw or with the large blade of an electric saw. The incision should be placed about 1 cm. to the right of the subject's midline and directed to the left at an angle of about 30° to enter the left side of the spinal canal as indicated in figure 15. The incision should start at the promontory of the sacrum and continue upward through the tenth thoracic vertebra or higher. The pedicles on the right are cut beneath the vertebral bodies with heavy bone cutting forceps or a chisel. The intervertebral discs at the upper and lower ends of the segment are removed by cutting with a knife. The broad chisel is driven into the saw cut to free the wedge-shaped segment of vertebral column. The anterior surface of the dura mater, the nerve roots, the dorsal root ganglia of the lumbar cord and the cauda equina are exposed. The spinal nerves are cut as far laterally as possible and the dura mater is cut completely around at its upper level of exposure. If the brain is not to be removed, the cord is cut as high as possible in the thorax of neck by inserting a narrow knife through an intervertebral disc. The cord may then be removed by exerting gentle traction on the dura. Restoration of the vertebral column seldom is necessary because sufficient rigidity is maintained by the remaining parts.

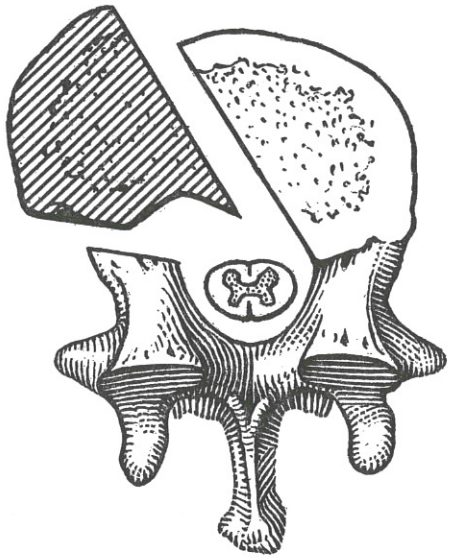

Figure 15.

48. Examination of Specific Peripheral Nerves and Neuromuscular Apparatus

When indicated, the peripheral nerves and the muscles they supply should be removed through longitudinal incisions in the skin (*special permission required.* Blocks of nerve tissue should be removed above and below the lesions and fixed in 10 percent formalin. Each block should be tagged individually or placed in a separate bottle of fixative with an identifying label.

49. Bones, Cartilages, Joints, and Bone Marrow

Whenever skeltal or joint disease is known or suspected roentgenograms should be obtained or consulted to aid in the selection of material. In many cases it is advisable to obtain the consent of the next-of-kin and to consult with the mortician before removing bones or joints. The mortician may wish to do part of the embalming before or during the autopsy. Bones or cartilage for grafting should be taken only from certain types of cadavers and the details and technique of selection should be discussed with the clinician who has requested the material.

50. Ribs

The study of nutritional deficiencies metabolic derangements and other effects on osseous and cartilaginous growth may require the removal of several costochondral junctions. These should be split or sawed longitudinally before fixation.

51. Calvaria

In certain anemias infections and other diseases, it is desirable to sample the calvaria. This can be done by removing bone from between two closely placed parallel saw cuts.

52. Digits

The small bones and joints of the hands and feet can be removed through palmar or plantar longitudinal incisions. The skeletal contours can be restored if necessary by inserting wooden substitutes for the resected bones. Special permission is necessary.

53. Extremities

a. The humerus may be reached through the usual Y-shaped body incision by cutting across the muscles of the anterior part of the axilla. The brachial vessels need not be severed. No additional skin incision is necessary unless the whole humerus is to be removed. If the capsule is opened the head of the humerus can be delivered by anterior dislocation. The muscle attachments can be progressively dissected away to the desired level. A small wooden rod, cut to the desired length, can be driven into the marrow cavity of the distal portion of the humerus and fixed to the acromion by means of a previously inserted nail (the head of a nail is sawed off and its blunt end driven into one end of the wooden rod). The proximal end of the rod is then wired to the glenoid fossa.

b. The femur can be delivered through an anteromedial incision in Scarpa's triangle cutting through the inguinal ligament and extending the skin incision for a few inches (fig. 1). After the anterior group of muscles is severed, the muscle attachments of the greater trochanter are cut away, the capsule and ligamentum teres are incised and the head of the femur is dislocated anteriorly. Muscle attachments to the shaft are then removed progressively, while traction is exerted on the head. The femur can be transected at the desired level and replaced with a wooden rod driven into the distal marrow cavity. The proximal end of the rod in which a nail has been fixed is pushed into the roof of the scetabulum. Unless the rod is somewhat longer than the portion of femur removed, it will be easily dislodged when the body is moved. A segment of cortex and bone marrow can be removed from the shaft as demonstrated in figure 16.

54. Knee Joint

The knee joint can be exposed by an anterior curved incision immediately below the patella. Flex the knee and carry the incision through the quadriceps tendon to expose the joint. To dislocate the joint, cut the capsule and cruciate ligaments and free the muscle attachments. Tissue from the articular surfaces, joint capsule, bursae, and tendons may be obtained. If the knee joint is to be removed as a unit, a longitudinal anteromedial incision is employed. The distal portion of the incision should be well above the hemline of the dress to be worn. The cooperation of the mortician is essential for this procedure, since loss of contour is inevitable. Prosthesis may be accomplished by driving a wooden rod into the cut end of the shaft of the femur and proximal tibia.

55. Sternoclavicular Joints

The sternoclavicular joints are readily removed and offer an opportunity for the simultaneous examination of bone and joint. Prosthesis is generally unnecessary except occasionally to restore contour in women.

56. Vertebrae

The vertebrae can usually be satisfactorily examined either by removing the anterior halves of the bodies by means of a coronal saw cut or by inspecting the blocks obtained in removing the spinal cord by the anterior route. If the vertebral column must be removed, the best approach is anteriorly from within the body cavity. Divide the soft tissues of the posterior abdominal wall where they attach to the vertebrae and transect the ribs near the transverse processes. Cut the intervertebral discs at the lowest and highest points of the selected specimen and dissect the bony mass from the body. The rigidity of the vertebral column should be restored by use of a stick of wood. Metal should be avoided in restoration, especially if the body is to be cremated.

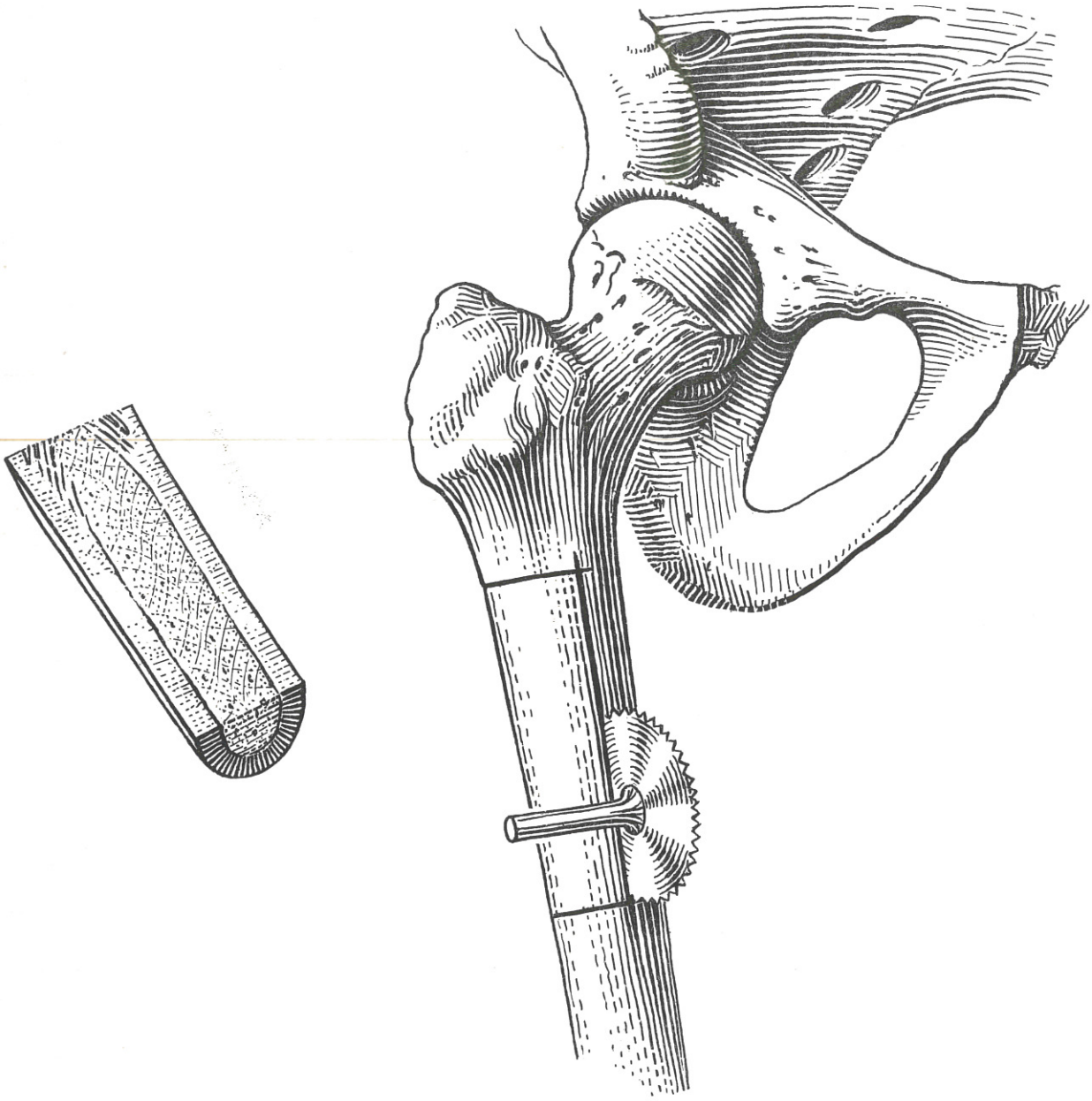

Figure 16.

57. Bone Marrow

Bone marrow may be obtained by the following methods:

a. Saw through the anterior one-third of a vertebra to expose the bone marrow. Dig out a block of bone marrow with a cartilage knife and place in 90 cc. of Zenker's fluid to which 10 cc. of glacial acetic acid has been added, for 24 hours. Wash in running tap water for 24 hours. Usually sufficient decalcification of the cancellous bone will have taken place to permit embedding and sectioning.

b. Scoop bone marrow from the femur from the incision demonstrated in figure 16.

c. Resect a segment of rib and squeeze out bone marrow by compressing the rib with a pair of pliers. Make smears on cover slips and slides and stain by Wright's method or with Giemsa stain after fixation for 2 minutes in absolute methyl alcohol. Dilute the bone marrow with an equal amount of serum to obtain thin spreads.

58. Examination of the Tissues of the Arm and Hand

A cardinal principle in all autopsies is that the skin of the face, the neck, the arms, and the hands must not be incised without *specific permission.* If the structures within the arm or hand must be examined, it is sometimes convenient to make a complete circular incision through the skin of the upper arm, and invert and roll the skin downward until the region to be examined is reached.

59. Examination of Tissues of the Face

Examination of the underlying tissues of the face should *not* be performed without *special permission* and important indication. None but the most expert should attempt this examination. The procedure is based upon the following steps; preparation of a death mask, thorough embalming and hardening of the skin and subcutaneous tissues, dissection of these tissues from the underlying bone, and final restoration by placing the embalmed skin in the death mask and recasting the facial features with plaster of Paris behind the skin.

Section IV. REMOVAL OF THE VISCERA EN MASSE (ROKITANSKY METHOD)

60. Instructions for Removal

a. Following the primary incision and inspection of the viscera of the thorax and abdomen, the first step in the removal of the organs *en masse* is the freeing of the structures in the superior orifice of the thorax from their attachments. The three major branches of the arch of the aorta are ligated close to their origin and divided below the ligatures, which should be left with ends at least 15 inches long for the use of embalmers. The trachea and esophagus are transected just below the larynx. The thoracic organs are elevated, pulled inferiorly, and separated by blunt or sharp dissection from the vertebral column. Sometimes it will be advantageous to remove the tongue, larynx, pharynx, thyroid glands, and parthyroid glands along with the organ mass. Since it is necessary to leave the carotid arteries intact for embalming of the face and head, it is necessary to observe each step so that all visible branches of the carotids can be ligated to prevent excessive leakage from the main arteries during the injection of embalming fluid.

b. The second step is the separation of the diaphragm and peritoneum from the lateral and posterior abdominal walls. On each side the diaphragm is cut from its attachment to the body wall in such a way that the incision enters the abdominal wall extraperitoneally. By blunt dissection the remainder of the diaphragm and the entire lateral and posterior peritoneal walls are separated from the underlying tissues. Dissection is carried posteriorly to the vertebral column, behind the kidneys and the adrenal glands.

c. The third step is the separation of the abdominal organs from the vertebral column. This is best accomplished by lifting the thoracic organs onto the left side of the body and rotating the abdominal organs to expose the right side of the vertebral column. By sharp dissection the vena cava and aorta are separated from the vertebral column. The mass of thoracic and

abdominal organs are replaced in the body cavity until attachments in the pelvis are severed. The fourth step is the insertion of a finger or blunt instrument into the extraperitoneal tissues of the retrosymphysial space and the separation of the bladder and prostate (or vagina) from the pelvic wall. Further dissection posteriorly will separate the rectum, which some pathologists tie by double ligatures 2 cm. apart and about 2 cm. above the anorectal junction. An amputation knife is employed to cut the urethra and associated structures as close to the pelvic outlet as is convenient. The rectum is severed 2 cm. above the anorectal junction (fig. 9). The pelvic organs may then be reflected upward and outward, exposing the great iliac vessels, which are divided along the brim of the pelvis. All of the tissues can be separated from the curve of the sacrum and the convexity of the lower lumbar vertebrae by blunt dissection. The entire organ mass can now be lifted from the body.

61. Removal of External Genitalia

a. If it is necessary to remove the tissues of the floor of the pelvis or part or all of the external genitalia, the incision in the abdominal wall should be extended inferiorly over the symphsis pubis to the base of the penis or to the crest of the labia majora. The symphysis pubis is divided with a large blunt cartilage knife and the legs abducted to expose the urogenital triangle. Further dissection will depend on the exigencies of the case.

b. In men the skin is incised on the dorsal surface of the penis, the contained tissue dissected free and taken with the pelvic organs, or a deep incision is made around the penis and scrotum to free these structures and leave them in continuity with the other pelvic viscera.

c. In women an incision around the labia and through the deep tissues will permit the entire external genitalia to be removed along with the pelvic organs.

62. Lungs

See paragraph 25.

63. Abdominal Viscera

Place double ligatures about the jejunum just below the ligament of Treitz. Beginning at the ileocecal valve, separate the colon by sharp dissection from the surrounding tissues as far as the rectosigmoid, which earlier was divided from the rectum.

64. Intestine

Use a long, sharp knife to separate the intestine from the mesentery as close as possible to the intestine. Open the intestine with blunt scissors or an enterotome along the mesenteric attachment. As the intestine is opened note the fluidity, color, and other characteristics of the intestinal contents. Take sections of representative regions. Do not rub the fingers over the mucosa or wash it with water before the sections are placed in fixative. Record the thickness, consistency, and color of the mucosa and of the wall as a whole. Open the colon along one of the taenia. The appendix may be examined by multiple cross sections or by a longitudinal incision through the lumen. Place selected segments of the wall of several parts of the intestine in fixative.

65. Stomach and Duodenum

Extend the previous incision in the esophagus along the greater curvature of the stomach and in the anterior midline of the duodenum, thus exposing the interior of the stomach and duodenum and the major papilla. Note the character of the contents and the state of the mucosa and wall.

66. Gallbladder, Ducts, and Porta Hepatis

Locate the common bile duct and with a scalpel open the lumen with a longitudinal incision. Use scissors to extend this incision as far downward as the ampulla and upward into the pepatic ducts and into the cystic duct. Note the character of the contained bile and the presence or absence of calculi. Open the gallbladder by making a longitudinal incision along its long axis so that bile can be collected in a clean, dry glass container. Record the color and fluidity of the bile. Examine for calculi. Examine the mucosa and the wall of the gallbladder. Open the portal vein and the splenic vein. Examine the hepatic artery.

67. Liver

The liver may now be detached by division of the gastro-hepatic and duodenohepatic ligaments. Separate the diaphragm from the supe-

rior surface of the liver by division of the triangular ligaments at their attachment to the liver. Weigh and measure the organ. The first incision in the liver should extend on the long axis and be directed from the greater convexity toward the porta hepatis. Further incisions should be parallel to the first. Place representative blocks including the capsule in fixative.

68. Spleen and Splenic Vessels

The superior surface of the pancreas should be exposed and the splenic artery and vein examined by multiple cross sections or by longitudinal incisions. The spleen may now be separated by division of the structures of the hilum. The parenchyma is exposed by a single incision extending from the greatest convexity toward the hilum. Further incisions should be parallel to the first. Fix a characteristic part of the organ including the capsule.

69. Pancreas

The most satisfactory incision of the pancreas is in the frontal plane, starting at the inferior edge and directing it toward the position of the splenic artery and vein. This exposes the greatest surface area and cuts across the pancreatic duct at one or more points. An alternative method is to make numerous parallel cross sections. Use small sharp-pointed scissors to open the major pancreatic ducts. Dissect the organ from adjacent structures, weigh and measure. Take blocks from the region of the tail, body and head for microscopic study. The tail contains the most islets and should be studied routinely.

70. Retroperitoneal Structures in the Midline

Place the organs on the table with the posterior surface upward. Use scissors to open the iliac veins and the inferior vena cava as far superiorly as the right renal artery, which should not be divided until it is opened. Dissect and examine the retroperitoneal lymph nodes. Open the iliac arteries and the aorta as far superiorly as the arch. Notice the size and character of the orifices of the major branches of the aorta, particularly the renal arteries.

71. Adrenals

From the region of the angle formed by the diaphragm, the aorta, and the kidneys, dissect and remove the adrenal glands. Free them of all extraneous tissue and examine by making parallel sections. Place all or part of both in 10 percent formalin.

72. Aorta and Vena Cava

Divide the aorta at the level of the diaphragm. Free the kidneys and ureters from the surrounding tissue and separate the aorta from the root of the mesentery by sharp dissection, noting the size and thickness of the wall of all branches. Reflect the aorta, renal arteries, and kidneys downward, following the ureters to the bladder. The kidneys, ureters, bladder, and associated structures can now be studied as a unit.

73. Other Organs

a. Esophagus.

(1) The next step in the dissection and examination of the viscera is to open the esophagus along the posterior midline. Examine the mucosa and wall. Elevate the esophagus and dissect it free from the adjacent posterior mediastinal structures as far inferiorly as the cardia. Cut a block and place in fixative.

(2) The thoracic and abdominal viscera may then be separated from one another by division of the inferior vena cava just above the caval hiatus in the diaphragm, leaving the diaphragm with the abdominal organs.

b. Kidneys (par. 36).

c. Bladder (par. 37).

d. Prostate (par. 38).

e. Rectum (par. 39).

f. Seminal Vesicles (par. 40).

g. Testis and Epididymis (par. 41).

h. Vas Deferens (par. 42).

i. Female Genitalia and Breasts (par. 43).

CHAPTER 3

PEDIATRIC AUTOPSIES WITH SPECIAL REFERENCE TO INFANTS AND FETUSES

Section I. PRELIMINARY CONSIDERATIONS

74. General

The sections dealing with various phases of autopsies performed on adult bodies are applicable to children and older infants, but special attention must be given certain details and the procedures modified in the case of newborn infants and fetuses.

75. Permission

a. A fetus under 22 weeks gestation, born dead, and measuring less than 25 to 28 cm. in length, is generally considered a surgical specimen. In such a case no autopsy permit, death certificate, or burial ceremony is required. It is important to know the local law in this respect since it varies somewhat in different localities. The local coroner or Public Health Officer should be consulted for legal procedure.

b. Regardless of the time of gestation or the measurements, a newborn infant that shows any evidence of life, even though it be only momentary, after complete birth, must be registered as a live birth, and a death certificate filed.

c. Legal permission is required to perform an autopsy on any child born alive, regardless of length of gestation or measurements. Such permission is also required in the case of newborn infants which are born dead but have developed to the stage of viability (par. 6*c*).

76. Proper Care of the Body

Viable infants and fetuses which are to be viewed after autopsy should be examined in such a manner that no incisions or mutilations will be visible. If there is little or no hair on the scalp, the skin incision for opening the head should be made as far posteriorly as practicable.

77. Clinical History

Since little or no history of the infant may be obtained, the clinical record of the mother should be consulted. Facts concerning pregnancy, labor, delivery, and past history, especially with regard to illnesses and pregnancies, may supply significant information. In some cases the blood type of mother and father and serologic studies for Rh antibodies in the mother are invaluable in final evaluation of the autopsy. Past history of siblings may also be helpful.

Section II. TECHNIQUE

78. Variations

The autopsy technique for newborn infants and fetuses varies in certain details from that used in adults or older children as follows:

a. External Examination. Special attention should be given to the gontanels, the umbilicus, the umbilical cord, and the placenta. Anomalous development should be noted. In cases of infectious disease of the central nervous system, an attempt should be made to obtain cerebrospinal fluid aseptically from the cisterna magna. This fluid can be used for smears, cell count, and cultures.

b. Primary Incisions. The primary incisions are the same as that used for adults, except the scalp incision is placed as far posteriorly as practicable. When the chest is opened, blood for typing and serologic tests and culture may be obtained.

c. Organ Removal. By using the method of block dissection and removal the relationships of the various structures can be better preserved. For example, anomalies of the cardiovascular system or genitourinary system can be shown to advantage by removing the heart and lungs or the entire genitourinary system as a unit.

d. Brain and Spinal Cord.

(1) The skull of a young infant or fetus is opened by the Beneke technique. Parasutural cuts which avoid the dural venous sinuses are made with a scis-

sors, and a parietal flap folded down on each side. By gently pushing aside the cerebral hemispheres and lifting the occipital poles of the brain it is possible to examine the region of the great vein of Galen, the falx cerebri, and the tentorium cerebelli for tears and hemorrhage.

(2) In older infants or children, the skull must be cut with a saw, as in adults. The spinal cord can be removed by either an anterior or posterior approach similar in principle to the methods used in adults.

79. The Placenta and Umbilical Cord

Autopsy of a newborn infant or fetus is not complete without examination of the placenta and umbilical cord. In most cases it is possible to determine whether twins are of single or of double ovum type by microscopic examination of the septum between the two amniotic cavities. In other cases, the weight and size of the placenta as well as the microscopic examination of the chorionic villi will aid in establishing a diagnosis of hemolytic disease of the newborn, congenital syphilis, or other disease.

80. Cause of Death

a. Although the physician in charge of the patient is responsible for signing the death certificate, he usually depends on the pathologist for help in establishing the cause of death. In many cases, the pathologist will be unable to find anatomical evidence of the cause of death, especially in an infant or child, but a careful study of the historical events and attention to details of the autopsy, together with microscopic examination, will often produce important evidence.

b. See appendix III: table II, Average Weights and Measurements of Normal Organs (Infants and Children); table III, Organ Weight in Relation to Body Weight in Newborn Infants; table IV, Criteria for Classification as to Period of Development.

c. For more details see: Potter, E. L.: *Pathology of the Fetus and Newborn.* The Year Book Publishers, Inc. 1952.

CHAPTER 4

AIRCRAFT ACCIDENT AUTOPSIES

Section I. GENERAL

81. Directives

The performance of autopsies on aircrew fatalities is now becoming a routine procedure. Its importance to flight safety cannot be overemphasized. The following governing directives should be consulted:

a. Joint Army, Navy, Air Force. AR 15–97; BUMEDINST 6510.6; AFR 160-127.

b. Army.

(1) AR 385–10, Safety.

(2) DA Pamphlet 95–5, Handbook for Aircraft Accident Investigators.

(3) TB AVN–8, U.S. Army Aircraft Accident Investigation.

c. Navy.

(1) Manual of the Medical Department, U.S. Navy, Article 17-24, Post-Mortem Examinations and Autopsies.

(2) OPNAVINST 3750.6B, Navy Aircraft Accidents, Incident and Forced Landing Reporting Procedure.

d. Air Force.

(1) AFM 62–5, Aircraft Accident, Prevention—Investigation—Reporting.

(2) AFR 62–14, Aircraft and Missile Accidents.

(3) AFR 160–35, Administering Medical Treatment Facilities.

(4) AFR 160–109, Medical Investigation of Aircraft Accident Fatalities.

82. Persons Authorized to Perform

a. The autopsy should be performed by a pathologist if available. When a pathologist is not available, the Senior Medical Officer should designate a physician to perform the autopsy.

b. When a prosector has had little experience with dissection, whole organs, such as the heart and lungs, properly fixed in formalin, may be forwarded to the Armed Forces Institute of Pathology, Washington 25, D. C. If there is evidence of toxic substances, toxicologic examination should be requested (paragraphs 107–112).

83. Knowledge of Accident

a. The autopsy should not be undertaken without specific knowledge of the accident, such as history of the flight, suspected cause of the accident, position of the aircrew, etc. It is helpful to visit the scene of the accident to gain firsthand information. Photographs of the body and aircraft are indispensable.

b. If the cause of the accident is well established, the prosector should try to determine how the crew member sustained his injuries and what measures can be taken to prevent similar injuries to others. *If the cause of the accident is unknown,* the prosector should gain as much information about the accident as possible before he starts the autopsy. The autopsy should be a meticulous study and should utilize as many adjunctive technics as needed.

Section II. RECORDING OF DATA

84. Medical Report of Aircraft Accidents

The medical investigations of aircraft accidents are reported in accordance with AR 385–40, OPNAVINST 3750.6C, AFR 62–14 and AFM 62–5.

85. Report of Autopsy

a. DD Form 1322 (Aircraft Accident Autopsy Report) (fig. 17) will be used.

b. The following information amplifies and explains pertinent data required and method of preparation:

(1) Items 1 through 12, deal with administrative data; in item 5 the time sequence of the accident should be expressed as date and time of day. Item 6 should give the altitude at the time of emergency; and if this is unknown it should be estimated.

AIRCRAFT ACCIDENT AUTOPSY REPORT

(Attach additional sheets of 8 x 10½ paper, as required)

DATE: 15 JAN 57

1. LAST NAME - FIRST NAME - MIDDLE NAME	2. GRADE	3. SERVICE NUMBER	4. AGE
DOE, JOHN JAMES	1/LT	A01234567	25

5. TIME *(Date, Days, Hours)*

LAST REPORT FROM PILOT	CRASH	CASUALTY SURVIVED	DEATH	AUTOPSY	6. ALTITUDE AT TIME OF EMERGENCY *(Estimated)*
1457 EST 15 JAN 57	1502 EST 15 JAN 57	SUDDEN DEATH	1502 EST 15 JAN 57	1800 EST 15 JAN 57	800 FEET

7. AIRCRAFT		8. CRASH SITE
TYPE	NUMBER	
T-33A	11-111	3 MILES S. E. OF ZIPPY AFB, COLORADO IN OPEN PLOWED FIELD

MEDICAL MEMBER OF BOARD

9. NAME	10. RANK/GRADE	11. SERVICE NO.	12. ORGANIZATIONAL UNIT
ROBERT R. STACK	MAJOR	55555A	4TH USAF HOSPITAL

13. MAJOR INJURIES *(List anatomical findings in order of importance stating probable cause of death and if possible, check which injuries were incurred ante- or post mortem.)* *(Attach additional sheets of paper, if required.)*

14. CHECK APPROPRIATE NUMBER TO INDICATE WHEN INJURIES WERE SUSTAINED: *1- In aircraft in air; 2- In aircraft on ground; 3- On ejection; 4- Other; 5- Indeterminate when received.*

LINE	INJURIES	ANTE-	POST-	
A	PARTIAL DECAPITATION W/AVULSION OF BRAIN	X		☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5
B	RUPTURE OF AORTA	X		☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5
C	MULTIPLE FRACTURES	X		☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5
D	3RD° BURNS, ENTIRE BODY		X	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5
E				☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

15. GIVE BRIEF DESCRIPTION OF FACTORS AND EVENTS LEADING TO ACCIDENT AND OTHER PERTINENT INFORMATION OR SUGGESTIONS

ON BANK FOR FINAL APPROACH, PILOT EXPERIENCED FLAMEOUT WITH SUDDEN LOSS OF ALTITUDE. PLANE CONTACTED GROUND LEFT WING AND NOSE LOW ALTITUDE. EXPLOSION AND FIRE ON IMPACT.

16. STATE BRIEFLY POSITION AND DISTANCE OF BODY OR FRAGMENTS WITH RESPECT TO AIRCRAFT WRECKAGE

INTACT BODY FOUND IN COCKPIT OF BURNING AIRCRAFT.

17. CONDITION OF WEARING APPAREL

ITEM	PRESENT	MARRED	TORN	DIS-COLORED	BURNED	IN-PLACE	OFF-BODY	OTHER
HARNESS	X				X	X		
PROTECTIVE HELMET	X	X			X		X	
VISOR	X				X			
OXYGEN MASK	X				X			
GLOVES	X				X			
CLOTHING	X		X		X	X		
SHOES OR BOOTS	X	X			X	X		
OTHER *(Specify)*								

CONDITION AND EXPOSURE OF BODY AT SITE OF CRASH

18. CONDITION *(Gross description, extent of fragmentation and details of exposure of fragments.)*

PARTIAL DECAPITATION WITH POST MORTEM
3RD DEGREE BURNS.

19. COULD THE DECEASED HAVE TAKEN SEVERAL BREATHS BETWEEN TIME OF CRASH AND TIME OF DEATH ☐ YES ☒ NO

20. EXPOSURE ☐ NONE

	FIRE PRIOR TO CRASH		WATER
X	FIRE AFTER CRASH		DIRT, MUD, ETC.
X	FUEL	X	OTHER *(Specify)* FOAMITE

SPECIFY TIME AND DEGREE

10 MINUTES - SEVERE

DD FORM 1 JUN 60 1322 REPLACES AF FORM 500, 15 OCT 56, WHICH IS OBSOLETE

Figure 17.

CONDITION AT AUTOPSY

21. BODY		22. REMARKS	23. PRESERVATION			
X	COMPLETE	3RD DEGREE BURNS ENTIRE BODY AVULSION SKIN & SUB-CUTANEOUS TISSUE EXTREMITIES	X	GOOD		ADVANCED POST MORTEM CHANGES
	RIGHT ARM AMPUTATED			EARLY POST MORTEM CHANGES		PUTREFACTION
	LEFT ARM AMPUTATED		24. STATE OF NUTRITION			
	RIGHT LEG AMPUTATED		☐ NORMAL	☐ OBESE	☒ SLENDER	
	LEFT LEG AMPUTATED		THICKNESS OF SKIN AND SUBCUTANEOUS TISSUE OF ABDOMINAL WALL (CM) 2CM			
X	DECAPITATED		WEIGHT OF BODY 150		LENGTH OF BODY 68"	
	DISINTEGRATED					

25. EXTERNAL/SKELETAL EXAMINATION

(Supplement with photographs where possible. Attach additional sheets of 8 x 10½ paper, as required.)

In each instance during External Examination specify exact location of the injury, abrasion, amputation, burn and degree, contusion, discoloration, hemorrhage, whether pre-existing or acquired. Also give opinion as to possible cause of injury.

In each instance during Skeletal Examination specify exact location and type of fracture or dislocation. X-rays to be used where possible. Give opinion as to probable direction and magnitude of force causing injury. Available skeletal diagrams should be used.

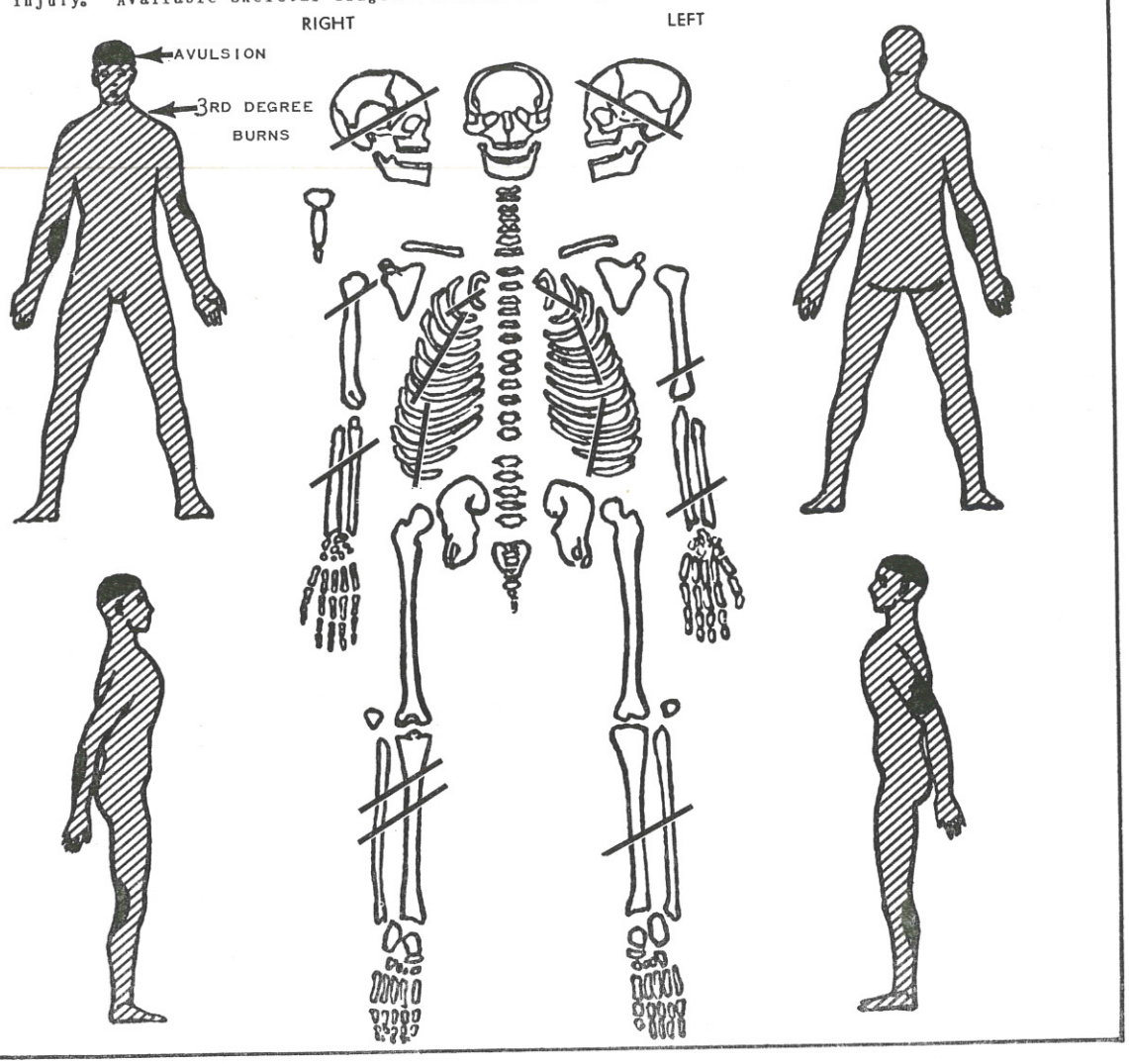

Figure 17—Continued.

INTERNAL

(The degree of injury should be assessed as Mild +; Moderate ++; Severe +++; or Extreme ++++; Organs showing significance pathologic changes should be preserved. Attach additional sheets of paper, as required.)

26. BRAIN
(The whole brain should be preserved in 10% N. Formalin after tissue is removed for toxicology.)

☐ NORMAL ☒ MISSING	☐ AIR EMBOLISM	WEIGHT	PRE-EXISTING LESIONS	CONTUSION	HEMORRHAGE (Degree)

LACERATION	CONDITION OF CEREBRAL VESSELS (Especially basilar)

27. SPINAL CORD
(Spinal cords are important, remove at all times)

☐ NORMAL ☐ MISSING	PRE-EXISTING LESIONS	DAMAGE SUSTAINED
	NONE	LACERATED SUPERIOR END

28. SINUSES

☒ NORMAL ☐ MISSING	HEMORRHAGE	OTHER

29. GLOTTIS

☐ NORMAL ☐ MISSING	LESIONS (Degree)	HEMORRHAGE

30. MIDDLE AND INNER EAR

	NORMAL	MISSING	HEMORRHAGE (Degree)	OTHER (Specify)
RIGHT	X			
LEFT	X			

31. EYES

	NORMAL	MISSING	HEMORRHAGE (Degree)	OTHER (Specify)
RIGHT			SEVERE	BURNED
LEFT			SEVERE	BURNED

32. ORAL CAVITY

☒ NORMAL ☐ MISSING	OTHER LESIONS
	NONE

33. LARYNX

☒ NORMAL ☐ MISSING	EDEMA	FRACTURE OF CRICOID BONE	FRACTURE OF THYROID BONE	HEMORRHAGE (Degree)	OTHER (Specify)
	NO	YES	NO	MODERATE	

34. PLEURAL SPACE

	NORMAL	MISSING	PNEUMOTHORAX	HEMOTHORAX (CC)	OTHER (Specify)
RIGHT			YES	175 cc.	
LEFT			YES	800 cc.	

LESIONS OF PLEURA

LACERATIONS OF PLEURA DUE TO RIB FRACTURES

35. TRACHEA

☐ NORMAL ☐ MISSING	VOMITUS	BLOOD	OTHER	EVIDENCE OF ANTE-MORTEM BURNING
	-----	YES	-----	NO

36. LUNGS
(Specify lesions by lobes when indicated)

	RIGHT	LEFT
NORMAL		
WEIGHT	520 GM.	465 GM.
MISSING		
ATELECTASIS	X	X
EDEMA		
RUPTURE		
FAT EMBOLISM		
HEMORRHAGE	X	X
EMPHYSEMA	X	X
MOTTLING — RIB MARKING		
MOTTLING — NO RIB MARKING	X	X
EVIDENCE OF DROWNING	NO	NO
OTHER (Specify)		

37. GREAT VESSELS

☐ NORMAL ☐ MISSING	PRE-EXISTING LESIONS
	SLIGHT ATHEROSCLEROSIS

TRAUMA (Describe) RUPTURE OF AORTA 2 CM. INFERIOR TO LEFT SUBCLAVIAN ARTERY.

38. PERICARDIUM

☒ NORMAL ☐ MISSING

PRE-EXISTING LESIONS: NONE

HEMOPERICARDIUM (CC): NONE

PETECHIAE ON VISCERAL SURFACE: NONE

RUPTURE	OTHER (Specify)
NO	NONE

Figure 17—Continued.

INTERNAL (Continued)

39. HEART

☒ NORMAL ☐ MISSING ☐ EVIDENCE OF AIR EMBOLISM	WEIGHT	PATENT FORAMEN OVALE (State size)	PRE-EXISTING LESIONS (Describe)
	300GMS	No	NONE

INJURIES (Describe)

DEGREE	INVOLVEMENT	CAUSE	ENDOCARDIAL RUPTURE
------	NONE	----	-----

FULL THICKNESS RUPTURE	STATE OF CORONARY VESSELS (Describe)
------	NORMAL

40. PERITONEUM

☒ NORMAL ☐ MISSING	PRE-EXISTING LESIONS	OTHER LESIONS	TYPE & AMOUNT OF FLUID
	NONE	NONE	NONE

41. STOMACH

☒ NORMAL ☐ MISSING	PRE-EXISTING LESIONS	DISTENTION	RUPTURE
	NONE	No	NONE

NATURE OF CONTENTS: . PARTIALLY DIGESTED FOOD

42. INTESTINES

☒ NORMAL ☐ MISSING	PRE-EXISTING LESIONS	DISTENTION (Describe)	HEMORRHAGE (Degree)
	NONE	No	NONE

OTHER LESIONS (Include mesentery): NONE

43. LIVER

☒ NORMAL ☐ MISSING	WEIGHT	PRE-EXISTING LESIONS
	1500 GMS	NONE

TRAUMA (Degree and cause): NONE

OTHER LESIONS (Describe): NONE

44. SPLEEN

☒ NORMAL ☐ MISSING	WEIGHT	PRE-EXISTING LESIONS
	160GMS	NONE

TRAUMA (Degree and Cause): NONE

OTHER LESIONS: NONE

45. PANCREAS

☒ NORMAL ☐ MISSING	WEIGHT	PRE-EXISTING LESIONS
	100GMS	NONE

TRAUMA (Degree and Cause): NONE

OTHER LESIONS: NONE

46. KIDNEY

	RIGHT	LEFT
NORMAL	X	X
MISSING		
WEIGHT	150 GM.	150 GM.
TRAUMATIC LESIONS (Describe)	NONE	NONE
OTHER LESIONS (Describe)	NONE	NONE

47. BLADDER

☒ NORMAL ☐ MISSING	PRE-EXISTING LESIONS
	NONE

DISTENTION: NONE

CONTENTS: 20 cc. OF URINE

RUPTURED: No

48. OTHER ORGANS

(Describe any lesions or traumatic changes noted in items listed below.)

THYMUS	THYROID	ADRENALS	GALL BLADDER
NORMAL	NORMAL	NORMAL	NORMAL
TESTIS AND PENIS	**PROSTATE**	**PITUITARY**	**LYMPH NODES**
BURNED	NORMAL	NORMAL	NORMAL

49. BIOCHEMICAL AND TOXICOLOGICAL STUDIES

(In the event studies are not immediately available, please forward)

YES	NO		YES	NO	
X		TISSUE LACTIC ACID FOR HYPOXIA		X	BLOOD SUGAR
X		BLOOD ALCOHOL	X		TISSUE CARBON MONOXIDE
X		TISSUE ALCOHOL	X		BLOOD CARBON MONOXIDE
		OTHER (Specify)			OTHER (Specify)

50. HISTOLOGICAL

(Attach additional sheets giving microsopic description and summary statement as to cause of death, antecedent causes or other significant conclusions.)

51. PATHOLOGIST PERFORMING GROSS AUTOPSY	52. ADDRESS
/s/ JOHN C. JACKSON, MAJOR, USAF (MC)	ZIPPY AFB, COLORADO
53. PATHOLOGIST PERFORMING MICROSOPIC STUDY	**54. ADDRESS**
/s/ PETER D. QUERIN, MAJOR, USAF (MC)	ARMED FORCES INSTITUTE OF PATHOLOGY 6825 16TH STREET, N. W. WASHINGTON 25, D. C.

Figure 17—Continued.

(2) Items 13 through 16, deal with the major injuries incurred and the circumstances of the accident. Items 15 and 16 should be as complete as possible and where indicated item 16 should be supplemented with photographs.

(3) Item 17, *Condition of Wearing Apparel,* concerns the condition of wearing apparel and protective equipment and should contain all details observed. Additional sheets of paper can be attached for full information if necessary.

(4) Items 18 through 20, *Condition and Exposure of Body at Site of Crash.* Item 18 in particular should offer information regarding the details of the condition of the body and the possible elements to which it has been exposed; the remainder of the form is concerned with observations at autopsy.

(5) Items 21 through 24, *Condition at Autopsy,* deal with the general inspection of the body surfaces. Any external observations which were not obvious on inspection at the site of the accident should be added in item 22.

(6) Item 25, *External Skeletal Examination,* deals with the external examination of the skeletal system. A complete study includes photographs and X-rays. Whenever fractures, lacerations, contusions, etc. are found, efforts should be made to ascertain their cause. Are skull fractures caused by striking against the instrument panel or control stick; are fractures of the extremities due to flailing or striking against specific fixed objects; are lacerations inflicted by hurled objects or by impact with some fixed structure on the aircraft? It is important to state whether lacerations are of the incised or bursting type. Fire alone can produce fractures, especially of the skull bones, and also cause loss of an extremity, which should be differentiated from traumatic amputation.

(7) Items 26 and 27, *Brain and Spinal Cord.* Air in the cerebral vessels is a common post-mortem finding when veins in this region have been severed and is not reliable evidence of air embolism. Large hemorrhages may appear to be the result of trauma, but a careful search should be made for cerebral aneurysm, especially about the base of the brain. Fire may cause the blood within the cranial cavity to boil and thus produce false epidural hemorrhage. Lacerations, contusions, and similar lesions should be carefully correlated with other findings. If brain tissue is not available, spinal cord may be submitted in the frozen state for lactic acid determination.

(8) Items 28 through 32, *Sinuses, Glottis, Middle and Inner Ear, Eyes, Oral Cavity,* are concerned with other structures within the head. Examination of the inner ears is most important in the study of spatial disorientation or vertigo, and these structures should be removed and forwarded as gross specimens (see removal of temporal bones, par. 54 *d,* and Fig. 14).

(9) Items 33 through 36, *Larynx, Pleural Space, Trachea, Lungs.* Study of the respiratory tract is the subject of above items. Large quantities of blood in the pleural cavity indicate limited survival after an accident, whereas small quantities suggest post-mortem trauma. Examination of the larynx, trachea and bronchial tree may reveal particles of black soot which indicate that the crew member inhaled smoke and thus was alive during the fire. It should be determined whether lacerations of the lung were made by rib fractures (and if so, by what ribs) or are the result of a crushing injury without rib fractures.

(10) Items 37 through 39, *Great Vessels, Pericardium, Heart.* The aorta must be examined for lacerations and ruptures. Lacerations may be caused by a fractured bone or compression against the vertebral column; rupture by sudden deceleration. Such ruptures are characteristically located in the ascending arch of the aorta, just distal to the left subclavian artery. The heart

CHAPTER 5

SPECIAL PROCEDURES

Section I. DESCRIPTIVE PROTOCOL

86. General Instructions

a. Describe the body as a whole and each organ, avoiding the use of diagnostic terms. Include weights and measurements where indicated, and describe the shape, color, consistency, and natural surfaces of each organ, also lesions and malposition.

b. To facilitate processing at the Armed Forces Institute of Pathology, Standard Form 503 (Autopsy Protocol) (fig. 18) will be used.

c. A *clinical abstract* obtained from the clinical records or furnished by the clinician, and *clinical diagnoses* should be next in order and completed in the format indicated below. When death occurs outside of a hospital, a statement concerning the circumstances surrounding death should be included in the autopsy protocol in lieu of the clinical abstract. These statements should be furnished by investigating officers as prescribed in applicable regulations of the services concerned. In cases of *death from trauma,* the cause should be stated, e.g., gunshot wound, automobile accident, poison (kind), and the circumstances surrounding the death, such as homicide, suicide, accident, etc. See Medicolegal Autopsy, chapter 6.

CLINICAL ABSTRACT

DATE OF ADMISSION:

COMPLAINTS:

1._____

2._____

3._____

HABITS: Alcohol, tobacco, narcotics, etc.

FAMILY HISTORY: List all information bearing on deaths, illnesses and hereditary tendencies.

PREVIOUS PERSONAL HISTORY: List all service in Army, Navy, or Air Force and duty in tropics.

PRESENT ILLNESS: Onset of present illness with chronologic abstract of illness.

PAST ILLNESSES: Include all illnesses, operations, wounds, venereal infections, and tropical diseases.

PHYSICAL EXAMINATION: Weight, height, temperature, pulse, respiration, and blood pressure. List all positive observations by systems.

LABORATORY AND X-RAY FINDINGS: Include *gross photographs,* and other pertinent materials, such as electrocardiographic interpretations or photographic copies of electrocardiograms, and significant X-ray films, or copies of these.

COURSE IN HOSPITAL: To include major therapeutic measures.

DATE AND HOUR OF DEATH:

CLINICAL DIAGNOSES

These should be listed numerically on Standard Form 503, (Autopsy Protocol) as indicated in figure 18.

Standard Form 503
Revised August 1954
Promulgated
By Bureau of the Budget
Circular A—32 (Rev.)

ROUTINE

CLINICAL RECORD	AUTOPSY PROTOCOL			
DATE AND HOUR DIED: 29 MARCH 1958, 8:26 A.M. / P.M.	DATE AND HOUR AUTOPSY PERFORMED: 31 MARCH 1958, 8:15 A.M. / P.M.	CHECK ONE: FULL AUTOPSY	HEAD ONLY	TRUNK ONLY
PROSECTOR: H. S. TRIPLER, CAPT., MC, USA	ASSISTANT	X		

CLINICAL DIAGNOSES *(Including operations)*

1. MYOCARDITIS OF UNKNOWN CAUSE.
2. HYPOCHLOREMIA AND HYPONATREMIA WITH HYPOVOLEMIA.
3. CARDIAC INSUFFICIENCY, SECONDARY TO DG. 1 AND DG. 2.

PATHOLOGICAL DIAGNOSES

CARDIOVASCULAR SYSTEM: 1. MYOCARDIAL HYPERTROPHY, IDIOPATHIC.
2. INTERSTITIAL FIBROSIS.
3. MYOCARDITIS, FOCAL, CHRONIC, SLIGHT.
4. ATHEROSCLEROSIS, AORTA, MINIMAL.

RESPIRATORY SYSTEM: 1. CHRONIC PASSIVE CONGESTION.
2. PULMONARY EDEMA.
3. ATELECTASIS, PARTIAL, LEFT LUNG.
4. INTERSTITIAL FIBROSIS, LEFT LUNG.

SPLEEN AND HEMATOPOIETIC SYSTEM: CHRONIC PASSIVE CONGESTION.

LIVER: 1. CONTROLOBULAR ANOXIC NECROSIS.
2. CHRONIC PASSIVE CONGESTION.

GALLBLADDER AND BILE DUCTS: NONE.

PANCREAS: CHRONIC PASSIVE CONGESTION.

GASTROINTESTINAL SYSTEM: ACUTE DUODENAL ULCERATION, DUE TO CANDIDA ALBICANS.

GENITOURINARY SYSTEM: NONE.

ENDOCRINE GLANDULAR SYSTEM: NONE.

CENTRAL NERVOUS SYSTEM: NONE.

BONE AND JOINTS: NONE.

MISCELLANEOUS: ASCITES.

APPROVED—SIGNATURE
BURTON C. WALKER, LT., MC, USA

MILITARY ORGANIZATION *(When required)*	AGE	SEX	RACE	IDENTIFICATION NO.	AUTOPSY NO.
	43	M	CAU	366-08-00	A-25-56

PATIENT'S IDENTIFICATION *(For typed or written entries give: Name—last, first, middle; grade; date; hospital or medical facility)*

REGISTER NO.	WARD NO.
14807	10

COOK, WYLLE M. LT.
WASHINGTON ARMY HOSPITAL, MOUNT VERNON, VIRGINIA

AUTOPSY PROTOCOL
Standard Form 503

U. S. GOVERNMENT PRINTING OFFICE 16—56214-4

Figure 18.

87. Gross Examination of Organs

a. Initial Procedure. Examine every organ in the body; collect representative sections of each for histologic studies and include skin, muscle, peripheral nerve, bone and marrow.

GENERAL: Approximate height and weight, age, color, sex, condition as to development and nutrition, degree of rigidity, character and distribution of lividity and degree of post-mortem decomposition. Detailed description of exterior, beginning with hair and going to feet, including marks of identification, superficial vessels, lymph nodes, and external genitalia.

PRIMARY INCISION: Subcutaneous fat, muscles, peritoneum, omentum, subperitoneal fat, position and relations of abdominal viscera, adhesions, fluid, intra-abdominal and mesenteric lymph nodes; height of diaphragm; pleural fluid; pericardium; thymus.

ORGANS OF NECK: Thyroid; parathyroids; larynx; pharynx.

LUNGS: Weight, relative size, consistency, pleura; cut surface of each lobe; bronchi; hilum; lymph nodes.

HEART: Weight, relative size; epicardium; musculature; valve leaflets; endocardium; coronary arteries; circumferential measurements of valve orifices and thickness of ventricular walls.

AORTA AND VESSELS:

SPLEEN: Weight, size, consistency; capsule, cut surface; color, dry or moist, markings; character of pulp.

LIVER: Weight, surface, consistency, color, and markings of surface and parenchyma.

GALLBLADDER AND DUCTS: Contents; mucosa.

PANCREAS: Weight, consistency, cut surface.

ADRENALS: Size, cut surface.

GASTROINTESTINAL TRACT: Esophagus, stomach and its contents; intestines; appendix.

GENITOURINARY TRACT: Kidney: Weight, size and consistency; capsule, subcapsular surface, cut surface; cortical markings, width of cortex; pelvis, pelvic fat, ureter; large vessels. Urinary bladder: amount and character of contents; mucosa; wall.

SEMINAL VESICLES:

PROSTATE: or UTERUS, OVARIES AND ADNEXA:

TESTICLES:

HEAD: Scalp; calvaria; dura, blood sinuses of dura; leptomeninges, fluid or exudate; base of skull.

BRAIN: Weight, convolutions and sulci; cerebral blood vessels; consistency; ventricles.

CORD: Dura; exudate; leptomeninges; appearance of cross sections at representative levels.

TEMPORAL BONE:

EAR:

SINUSES OF SKULL:

EYES:

BONE MARROW: Ribs, sternum, vertebrae, shaft of femur (when there is a hematologic problem).

MUSCLES:

BONES AND JOINTS:

BACTERIOLOGIC EXAMINATIONS:

CHEMICAL EXAMINATIONS:

b. Cause of Death. After completion of the gross autopsy the pathologist should supply the attending physician with the important pathologic diagnoses to aid him in establishing the cause of death. In some cases no anatomical cause of death can be found at autopsy. In some cases subsequent microscopic, chemical and bacteriological examination will change the pathologic diagnosis. Such changes must be reported to the clinician or to the local bureau of vital statistics. In the case of a medicolegal autopsy, the pathologist is responsible for determining the cause of death and uncovering evidence which may be of legal importance. See chapter 6.

88. Microscopic Description of Organs

HEART: Epicardium, epicardial fat, endocardium, myocardium, interstitial tissue, valves, vessels.

LUNGS: Pleura, alveolar spaces, alveolar walls, interstitial tissue, bronchi, vessels.

LIVER: Capsule, architecture, central areas, portal areas, interstitial tissue, fat hemorrhage, necrosis, pigment. *Gallbladder:* mucosa, wall.

PANCREAS: Acinar parenchyma, islets, ducts, vessels.

SPLEEN: Capsule, malpighian bodies, red pulp, trabecule, vessels.

ADRENALS: Cortex, medulla, tumors, vessels.

KIDNEYS: Glomeruli, tubules, interstitial tissue, vessels, pelvic mucosa.

PELVIC ORGANS:

Bladder: Mucosa, submucosa, muscularis.

Prostrate: Glands, stroma, hyperplasia, inflammation.

Seminal Vesicles: Mucosa, infection, concretions.

Testes: Tubules, basement membrane, atrophy, spermatogenesis.

Uterus: Endometrium, myometrium, tumors.

Vagina: Mucosa and submucosa.

Ovaries: Stroma, cysts, corpora albicantia and lutea, vessels.

LYMPHATIC SYSTEM: Capsule, architecture, follicles, stroma, pigment, reticulo-histiocystic components.

THYROID: Acini, stroma, degenerative changes.

BONE MARROW: Proportion of fat to hematopoetic elements. Normoblasts, myeloid elements, megakaryocytes. Hyperplasia or hypoplasia.

SKELETAL SYSTEM: Condition of trabecular bone, osteoblastic and osteoclastic activity.

BRAIN: Meninges, parenchyma, vessels, perivascular infiltrations, ependyma.

89. Final Summary of the Case (Epicrisis)

No autopsy protocol is complete without a final summary in which the prosector evaluates his findings and correlates them with the clinical history. Such an epicrisis should consist of:

a. An abstract of about 100 words of the pertinent clinical history and of the clinical diagnostic problem. It should not duplicate the detailed clinical abstract which is furnished by the attending physician.

b. A concise statement of the principal gross and microscopic observations at autopsy. This should not be a copy, but an abstract, of the diagnosis sheet.

c. A discussion of the pathogenesis of the illness and the evolution of the structural changes which eventually led to death, based on the autopsy findings and the clinical history.

d. Where applicable, a discussion of the effects of therapy.

e. The prosector should state what he learned from the case or what the case should teach.

Section II. EXAMINATION FOR MICROORGANISMS

90. Post-Mortem Investigation

An adequate post-mortem investigation of the tissues for microorganisms is as important as the morphological study and may yield the only positive proof of the exact nature of a pathological process. The pathologist is responsible for the collection of the material for culture. If a bacteriologist is available he should collaborate with the pathologist in the selection and collection of material for cultures.

91. What to Culture

If indicated, prepare aerobic and anaerobic cultures of the heart's blood on both solid and liquid media. If the lesions suggest a possible bacterial etiology prepare cultures from other tissues. If a sulfonamide has been administered, add para-aminobenzoic acid (between 2 and 5 mg. per 100 cc., or 1 to 2 granules of the powdered form) to each culture medium. If para-aminobenzoic acid is not available, hold the cultures for at least a week before reporting them sterile. If penicillin has been administered, and 0.1 cc. of penicillinase to 10 to 12 cc. of media. If other broad spectrum antibiotics have been administered collect the specimen in large amounts of culture medium containing 0.1 percent agar to reduce the concentration of the drug; hold the cultures for at least one week before reporting them sterile.

92. How to Obtain Material For a Culture

During the course of an autopsy the surface of the organs becomes grossly contaminated. Precautions must be taken to destroy these contaminating organisms and to secure material for culture from the deeper tissues only. Hold a spatula over a gas burner until it is red hot and apply it to the surface of the tissue from which the culture is to be taken. Hold the spatula on the area until the tissue is seared and thoroughly dry. Do not allow the area to become contaminated by contact with surrounding tissue and fluids before the culture is taken.

93. Techniques

There are several techniques for securing material for culture:

a. Heart's Blood. Plunge a pipette (glass tube drawn to a point and sterilized) or a sterile hypodermic needle (18 to 20 gauge, 3 in.) attached to a 20 cc. sterile syringe, through a seared area on the wall of the atrium or ventricle and draw the blood by suction. If the heart has already been removed from the body, blood sometimes can be obtained from the femoral vein, portal vein, or vena cava.

b. Solid Viscera. With a sterile, sharp instrument break the surface in a seared, dry area and plunge a sterile applicator stick, with its end lightly covered with cotton, into the substance of the organ. Withdraw the stick and replace in the sterile test tube, but do not allow the portion of the applicator held by the fingers to enter the tube. A small amount of sterile broth or normal saline solution must be in contact with the swab in the test tube, otherwise the culture will soon dry and be worthless. If actual tissue is desired, remove a block of about 1 cc. with sterile forceps and scissors from beneath the seared surface. Place the block in a sterile container and later grind it in mortar with sterile broth. Use the suspension to inoculate appropriate media.

c. Leptomeninges. If the dura is intact after removal of the calvaria, it may be reflected from the cerebral hemisphere and cultures of the leptomeninges taken with a swab or pipette without searing of the surface. Otherwise, the leptomeninges must be seared with the heated spatula, which may kill the organisms immediately beneath it. To obtain viable organisms the swab or pipette should be inserted through the seared area and directed through the subarachnoidal space into an adjacent unheated, uncontaminated region.

d. Deep Freezing for Subsequent Cultures. Representative fresh tissues frozen at the time of necropsy may prove essential to diagnosis in the event that histologic study indicates a need for cultures.

e. Special Cultures. Many microorganisms grow poorly or not at all on routine culture media, therefore, the bacteriologist should be given full information concerning the exact nature of the disease and the character of the lesions, in order that he may do intelligent and accurate work. The more important diseases requiring special conditions for cultivation and isolation of the microorganism are tuberculosis, tularemia, brucellosis, pertussis, gonorrhea, and influenza. For preservation of material from spirochetal diseases draw blood or tissue fluid into capillary tubes, 8 to 10 cm. in length. Seal the ends of these tubes by melting the glass in a flame. The *treponema pallidum* may remain active for as long as 48 hours under these conditions.

94. Study of Fungi

a. Direct microscopic examination of pus, other fluid, or material from ulcers should be examined without staining by placing a drop on a slide and pressing it gently under a cover glass to make a thin smear. If necessary, the material may be cleared by placing it in a drop of 10 percent potassium hydroxide on a slide, covering with a glass slip and gently warming the slide.

b. Spinal fluid should be examined in the same way as pus, except that it should be centrifuged and the sediment examined directly. When cryptococcosis is suspected, place a drop of sediment in a drop of India ink on a slide, cover with cover slip.

c. All materials from cases of suspected myotic infection should be *cultured* for fungi regardless of whether fungus cells are found on direct examination. As a routine procedure, it is suggested that blood agar plates be streaked, and Sabouraud's glucose agar slants inoculated, with material obtained from lesions. The blood agar plates should be incubated at 37° C. and the Sabouraud's slants kept at room temperature.

95. Smears

Direct examination of smears stained for bacteria may yield valuable information. In many protozoal diseases thick films of blood or tissue fluid should be prepared. Touch a clean slide to a drop of blood or tissue pulp and allow it to spread over an area about 1 cm. in diameter. Dry at 37° C. for one hour, or in a horizontal position at room temperature overnight in a dust-free atmosphere. Such smears should be stained with Giemsa stain within 48 hours, because they deteriorate on standing.

96. Disposition of Cultures

If a skilled bateriologist is not available locally, send the material collected at autopsy immediately to a bacteriological laboratory. Attach a short note containing information that will serve as a guide in the selection of culture media and conditions of incubation. In smaller laboratories the pathologist may carry out the simpler isolations and identifications, but material from all important and doubtful cases should be sent to a laboratory equipped for bacteriological examinations. If the pathologist or clinician knows that a patient with an unusual bacterial disease is on the wards of the hospital, he should consult with a bacteriologist in order to anticipate what autopsy material will be required to establish the diagnosis. If facilities for bacteriological studies are not available, the blood and tissues collected at autopsy should be placed in sterile vessels, frozen with dry ice, and shipped to a bacteriological laboratory. Pertinent data should be sent with the specimens.

97. Handling and Shipping Instructions

Information concerning the handling and shipping of specimens for examination for microorganisms may be obtained from area laboratories, TB MED 237, "Collection and Preparation of Specimens for Shipment to Medical Laboratories": BLUMEDINST. 6510.2, "Central Facilities Provided for Department of Defense by Armed Forces Institute of Pathology and Histopathology Centers"; and BUMEDINST. 6510.3A, "Directions for Utilization of Laboratory Services Available at the U. S. Naval Medical School, National Naval Medical Center, Bethesda 14, Maryland."

Section III. SPECIAL STUDIES OF VIRAL DISEASES

98. Suspected Viral Diseases

a. In any case of suspected viral disease, steps should be taken to identify the typical histological changes in the tissue and to isolate the virus.

b. For cytological studies fix representative blocks of tissue in Bouin's fluid or Zenker's fluid and cut in the usual way. For the isolation of the virus, not less than 10 gm. of fresh tissue should be removed with sterile precautions from the lesions.

c. In view of the opportunities provided for diagnosis by means of tissue culture, submit fresh frozen tissues for isolation viruses. Samples of fluids such as whole blood, respiratory tract-exudate, or intestinal content should be frozen separately. Each specimen of fresh tissue or fluid should be placed in a *separate* sterile, airtight container of glass, metal, or plastic and sealed to prevent the entrance of carbon dioxide. The acidity of absorbed carbon dioxide is determental to many virsuses and may inactivate them. If possible, the material should be quick-frozen in dry ice, but it can be preserved in 20 volumes of 50 percent buffered glycerol for each volume of tissue.

d. Directions for the preparation of *sterile buffered glycerol* are:

(1) Citric acid 21 gm. to 1,000 cc. double distilled water.

(2) Anhydrous Na_2HPO4 28.4 gm. to 1,000 cc. double distilled water.

(3) Take 9.15 cc. of (1) above and 90.85 of (2) above to make 100 cc. of buffer solution pH 7.4.

(4) Mix equal parts of (3) above and C. P. glycerol; fill cork-stoppered specimen bottles half full and sterilize at 15 lb. of steam pressure for thirty minutes.

e. If buffered glycerol is not available, sterilize a solution containing 50 percent glycerol and 0.9 percent sodium chloride. If dry ice is available, place each 10 gm. sample of tissue in a separate sterile test tube or glass bottle and keep frozen.

f. In viral diseases of the central nervous system it is desirable to have blocks of fresh tissue, about 10 gm. each, from the following 9 regions:

(1) Temporal lobe, including the hippocampus
(2) Motor cortex
(3) Olfactory bulbs
(4) Midbrain
(5) Thalamus
(6) Pons and medulla
(7) Cerebellum
(8) Cervical cord
(9) Spinal cord as indicate

g. Blocks of tissue immediately adjacent to the tissue removed for viral studies should be fixed in Zenker's or Bouin's fluid for microscopic study. Blocks should not exceed 2 mm. in thickness. Specimens from cases of rickettsial disease should be fixed in Regaud's fluid.

h. At autopsy, obtain enough blood aseptically to provide approximately 10 cc. of serum. The blood should be refrigerated immediately, the serum separated as soon as possible and stored without preservative in a tightly stoppered sterile tube. The tube should be labeled with the patient's name, autopsy number or other identification and the date of collection. It should be refrigerated or frozen and submitted with the tissue for virus isolation, together with any serum previously obtained from the patient. The serum may be used to obtain a diagnosis by serological means in the event that a virus is not isolated.

99. The Collection and Handling of Brain Tissue at Necropsy for the Diagnosis of Rabies

a. A face shield or goggles and rubber gloves to protect the prosector are essential during the exposure and removal of the brain. Take 1 cc. blocks of tissue aseptically from the hippocampus, cerebellar cortex, medulla, pons, thalamus, and cerebral cortex of one cerebral hemisphere and pool for virus isolation. If virus isolation is to be attempted on the same day refrigeration is adequate; if not, freeze the pooled tissue.

b. Take from the opposite cerebral hemisphere approximately 1 cc. blocks of tissue from the hippocampus, cortex of the cerebellum, and the frontal and paretal lobe of the cerebrum. Fix one-half of each block in Zenker's fluid. Make impressions from the other half of the blocks by pressing slides on the cut surface, and stain while still *moist* with Seller's stain. If the impressions cannot be stained at once they may be fixed while still *moist* for two minutes in absolute C. P. methyl alcohol.

100. Technic for Negri Bodies in Impressions

a. Seller's Stain. Immerse slides while the impression is moist in Seller's stain for 1 to 5 seconds depending on thickness of impression. Rinse gently under running tap water, and air-dry (do not blot). Examine thin areas with the oil-immersion lens. Negri bodies stain bright cherry red. They are round or oval bodies up to 23 microns in diameter, in which vacuoles containing basophilic granules usually can be demonstrated. Cytoplasm of nerve cells stains purplish-blue, nuclei and nucleoli deep blue, and stroma pink. The formula for Seller's stain is:

(1) Stock Solution A. Dissolve 1 gm. of basic fuchin in 100 cc. of absolute, acetone-free C. P. methyl alcohol.

(2) Stock Solution B. Dissolve 1 gm. of methylene blue in 100 cc. of absolute, acetone-free C. P. methyl alcohol.

(3) Store both solutions in glass-stoppered bottles.

b. Working Stain. Take one part of Stock Solution A (basic fuchsin) and mix with two parts of Stock Solution B (methylene blue). Mix but do not filter.

101. Technic for Negri Bodies in Smears

a. With a small scissors cut through Ammon's horn (hippocampus). Clip a piece from the cut surface no larger than a grain of rice (a portion of the hippocampus previously removed may be used). Also use a piece of tissue from the cerebellar cortex.

b. Transfer tissue to a clean slide near one end. Press this out flat by means of another slide. Draw the top slide along the length of the bottom one, leaving a thin smear.

c. Stain with Seller's stain by the same technic as described for impressions. *It must be stained before it dries.* If staining cannot be done immediately, fix for 2 minutes while the smear is still moist in absolute C. P. methyl alcohol.

102. Technic for Negri Bodies Zenker Fixed Tissue (Schleifstein's Stain)[1, 2]

a. Wash Zenker-fixed tissue for 24 hours in running tap water. Embed in paraffin and cut sections at 6 microns.

b. Solutions:

STOCK SCHLEIFSTEIN'S STAIN

Solution A

Basic fuchsin	1.8 gm.
Methylene blue	1.0 gm.
Glycerin	100.0 cc.
Methyl alcohol	100.0 cc.

This solution will keep indefinitely.

[1] Schleifstein, J.: Am. J. Public Health. 27:1283–1285, 1937.

[2] Manual of Histologic and Special Staining Technics. Armed Forces Institute of Pathology, Washington 25, D. C. 1957, pp. 194–195.

Solution B

Potassium hydroxide, 1:40,000 aqueous solution, or tap water which is slightly alkaline.

Working Schleifstein's Solution

Solution A ..... 10 drops
Solution B ..... 20 cc.
Mix the working solution in a small vial immediately before use.

5% IODINE SOLUTION

Iodine ..... 5.0 gm.
Alcohol, 70% ..... 100.0 cc.

5% SODIUM THIOSULFATE (HYPO) SOLUTION

Sodium thiosulfate ..... 5.0 gm.
Distilled or tap water ..... 100.0 cc.

c. Staining Procedure:

(1) Deparaffinize sections in usual manner. Run through absolute and 95 percent alcohols to distilled water.

(2) Remove mercury precipitates in 5 percent iodine solution for 5 to 10 minutes.

(3) Rinse in running tap water for 2 minutes.

(4) Clear in 5 percent sodium thiosulfate solution for 5 to 10 minutes.

(5) Wash in running tap water for 10 minutes, rinse in distilled water.

(6) Place sections on warm electric hot plate, flood with freshly prepared Schleifstein's solution, and steam gently for 5 minutes.

(7) Cool and wash quickly in tap water.

(8) Decolorize and differentiate each slide individually by gently agitating in 90 percent alcohol until sections are faint violet color.

(9) Dehydrate with 2 changes of 95 percent alcohol, clear with xylene, and mount in Permount.

d. Results:

(1) Negri bodies—deep magenta.

(2) Cytoplasm—bluish violet.

(3) Erythrocytes—copper.

e. In installations not equipped for the diagnosis of rabies in human autopsy cases the following should be done:

(1) Freeze tissue blocks from appropriate parts of the brain as previously described (Viral studies).

(2) Place appropriate blocks of the brain in Zenker's fluid as described above for 24 hours. Wash for 24 hours in running tap water, and place in 80 percent ethyl alcohol for shipment (paraffin sections).

(3) Make smears and impressions of appropriate parts of the brain; fix for 2 minutes in absolute C. P. methyl alcohol, remove and dry. Or appropriate parts of the brain may be placed in a container surrounded by another containing ice and the receiving laboratory will make smears (for Seller's stain).

f. This material is to be sent to the nearest laboratory equipped to diagnose rabies which includes U. S. and State Public Health Laboratories, Army Area Laboratories, and many U. S. Naval Hospital Laboratories. Do not send initially to the Armed Forces Institute of Pathology.

g. If an animal is suspected of having rabies, keep the animal alive as long as possible. If the animal dies, cut off his head, place it in a water tight container, seal and pack in a larger can of ice and deliver to an installation equipped for the diagnosis of rabies within the melting time of ice. Examination for suspected rabies in an animal brain is an emergency procedure.

h. Further information concerning material desirable for virological examination in particular diseases and methods of preservation and handling may be obtained from "Diagnostic Procedures for Virus and Rickettsial Diseases," second edition, American Public Health Association, 1790 Broadway, New York City, 1956.

Section IV. IMMUNOLOGICAL EXAMINATION

103. Relation of Virus to Disease

The isolation of a specific bacterium or virus from the tissues does not prove that it is the cause of the disease from which the individual died. The bacterium may be a contaminant or a secondary invader. A virus found after animal passage may be a virus indigenous to the animal used for experimental inoculation. Proof of the relation of a bacterium or virus to the disease may be obtained by the demonstration of im-

mune bodies in the serum. In all autopsies on patients suspected or known to have died of a bacterial or viral disease, 25 cc. of blood should be removed under sterile conditions from the heart and placed in sterile centrifuge tubes.

104. Preservation of Serum

Immediately on completion of the autopsy, the sample of blood should be centrifuged, the serum removed with sterile pipettes and kept in sterile tubes in the refrigerator. If possible, tubes of serum without preservative should be held and shipped frozen in dry ice. An alternative is to hold the serum samples under refrigeration and ship via air mail. Preservatives are not recommended because they interfere with neutralization tests. When neutralization tests are not indicated and delivery to the laboratory may be delayed, 0.3 percent cresol may be added as a preservative.

Section V. RADIOACTIVE CADAVERS AND SPECIMENS

105. Precautions in Handling

a. A radiological safety officer should be available for consultation in any institution where radioisotopes are employed, and film badges as well as dosimeter service should be provided for personnel exposed to radioactive material. The bodies of patients who die following therapeutic administration of radioisotopes should be carefully monitored and labeled with a red tag indicating type and quantity of radioisotope and time of administration, radiation level at time monitored, and the decay rate of the isotope used. This precaution is the responsibility of the doctor who transfers the body to the morgue and of the pathologist who transfers the body to a mortician. The radiation level should be personally certified and signed by the radiological safety officer.

b. The pathologist should not perform an autopsy on a radioactive body without consultation with the radiological safety officer and this officer should be present at the autopsy to monitor the opened cadaver and specimens.

c. The clothing of the pathologist and assistants must be protected from contamination by radioactive material. A long, heavy, rubber apron should be worn beneath the usual cotton operating gown. Fluids which may contaminate the gown will be absorbed by the cloth rather than reach the trousers and shoes. High rubber boots can be worn during particularly hazardous autopsies. Since the danger from gamma radiation will probably be inconsequential, contact with radioactive foci emitting beta particles is the chief concern. For this reason the hands, wrists, and forearms should be protected by long, double, heavy rubber gloves. The face should not be allowed to come close to radioactive foci in the examination of body cavities or organs. If this precaution is observed, the face need not be protected by a mask. However, body fluids which may splash the face should be washed off immediately with several rinses of tap water. It is advisable to protect the eyes with spectacles or goggles.

d. According to the National Committee on Radiation Protection Subcommittee on Permissible Dose from External Sources, the maximum permissible weekly dose is 0.3r to the whole body, and five times as much to the hands and forearms.

106. Handling, Disposition, and Storage of Radioactive Material

a. Radioactive organs and body fluids should be stored or discarded expeditiously under the direction of the radiological safety officer. In some cases, blood, urine, and serous fluids may be drained directly into the sewer system, if authorized by the radiological safety officer. Otherwise, these fluids as well as organs and radioactive tissue specimens must be stored in thick-walled containers bearing red warning labels listing their level of radioactivity and safe time for disposition. During the period of significant radioactivity, the containers should be stored in a special room or specified safe location.

b. Foci of intense radiation should not be handled directly. Forceps, at least 10 cm. in length, and a long knife are used to manipulate or resect organs and to remove sectioned pieces of organs. Drainage tubes and trochars are held with the forceps during the withdrawal of blood and body fluids.

Chart I. Probable radioactive content of body at various times after various doses

A guide for autopsy consideration. For values *in italics*, no precautions are necessary except wearing surgical rubber gloves. For values *not* in italics, consultation with radiological safety officer is indicated.

Dose of isotope	Days elapsed since treatment							
	1	2	3	4	6	8	10	15
Au^{198}	Gold remaining in injected cavity							
mC	*mC*	*mC*	*mC*	*mC*	*mC*	*mC*	*mC*	*mC*
150	115	90	69	52	32	20	12	*3*
125	96	75	58	44	27	16	10	*3*
100	77	60	46	35	21	13	8	*2*
75	58	45	35	26	16	10	6	*2*
50	38	30	23	18	11	7	*4*	*1*
40	31	24	18	14	9	5	*3*	*1*
30	23	18	14	10	6	*4*	*2*	*1*
I^{131}	Iodine remaining in thyroid gland following dose for ablation of normal thyroid tissue							
60	18	16	14	12	10	8	6	*4*
50	15	13	12	11	9	7	5	*3*
40	12	10	9	8	7	5	*4*	*2*
30	9	8	7	6	5	*4*	*3*	*2*
20	6	5	5	*4*	*4*	*3*	*2*	*1*
10	*3*	*3*	*2*	*2*	*2*	*1*	*1*	*1*
I^{131}	Iodine remaining in functioning metastases following therapeutic dose post-thyroidectomy. (These are maximal; usually much smaller)							
100	20	18	16	14	12	9	7	*4*
75	15	13	12	11	9	7	5	*3*
50	10	9	8	7	6	5	*4*	*2*
35	7	6	5	5	*4*	*3*	*2*	*1*
20	*4*	*4*	*3*	*3*	*2*	*2*	*1*	*1*

c. After the organs, tissues, and fluids of greatest radioactivity have been removed, additional monitoring of the body by the radiological safety officer will indicate what further precautions are needed in completing the autopsy. If the level of radiation is not greater than 30 mr/hr when measured 1 cm. from the tissues, the gloves and clothing previously described will be adequate protection and the tissues can be handled directly. The radioactivity in any given localized area will depend on the time elapsed since administration of the isotope. The decay rate of Au^{198} is about 25 percent per diem and that of I^{131} is roughly 9 percent per diem. The probably radioactive content of the body at certain times after various doses can be ascertained from the radiological safety officer or from chart I.

d. If advisable, autopsy of a radioactive cadaver may be delayed until the radioactivity falls to a safe level. Since dosage is determined not only by the radiation level but also by the length of exposure, the pathologist may limit the dosage to himself by increasing the speed of the post-mortem examination or by alternating with another pathologist.

e. After completion of the autopsy, the cleaning of the autopsy room and disposition of instruments, gloves, and other material should be supervised by the pathologist and the radiological safety officer. The body should be tagged with a red label indicating to the mortician the presence of radioactive material, dosage, radiation level at time monitored, and the decay rate of the radioisotope used.

Section VI. COLLECTION AND SHIPMENT OF SPECIMENS FOR TOXICOLOGICAL EXAMINATION

107. Preservation and Shipment of Specimens and Continuity of Custody of Evidence

(See figure 19 for sample fill in of DD Form 1323 (Toxicological Examination—Request and Report)).

a. Each specimen should be placed in a separate, chemically clean, glass vessel with a tightly fitting cap. Before taking specimens, measure the total quantity of fluid and weigh each of the viscera, in order that the determinations may be quantitative. Label each glass vessel with all

information required for identification of the specimen. Wrap each specimen in heavy paper, tie with cord, and seal the top, bottom, free edge, and knot with sealing wax. Mark the wax with some distinctive device in such a manner that tampering would be immediately evident. Keep all specimens so prepared in your immediate possession, or safetly locked up, until they are shipped or otherwise delivered to the toxicologist.

b. If the body has been embalmed, or if the tissues have come in contact with any chemical preservative, send a separate sample of this solution to the toxicologist. If a preservative must be used, 95 percent ethyl alcohol is preferred. A preservative should not be employed when one of the poisons in question is ethyl alcohol or any other alcohol.

c. When specimens must be shipped to a distant laboratory, refrigeration by ice or dry ice is the best method of preservation. Place the solid dry ice in paper bags on top of the specimen and seal the package with strips of gummed paper. This is adequate for 24 hours. If ordinary ice is used, the material should be shipped by express, and arrangements made to have it re-iced enroute. DD Form 1323 will be submitted in triplicate when forwarding specimens to Armed Forces Institute of Pathology. One copy will remain at AFIP in the patient's folder, two copies will be returned to the contributor. A clinical and/or autopsy protocol may accompany DD Form 1323.

108. Specimens Best Suited for Particular Poisons

In all cases of poisoning or suspected poisoning the following samples should be obtained for toxicological examination: brain, 500 gm.; liver, 500 gm.; blood, 500 cc.; urine or bile, all available; 1 kidney (or equivalent); 1 lung (or equivalent); 10 gm. of hair; and the contents of the stomach and of the intestinal tract. Each specimen should be placed in a separate container.

109. Specimens From Cases of Suspected Drowning

If drowning is suspected, take samples of not less than 10 cc. of blood from both right and left chambers of the heart, using pipettes with relatively large openings, and being careful not to perforate the septum. Label the bottles "left heart" and "right heart." In addition, secure a sample of water from which the body was recovered. By determination of the amount of chloride and magnesium in each of the 3 specimens, occasionally it is possible to prove that death resulted from drowning. Some pathologists consider the specific gravity of the heart blood more reliable than the electrolyte concentration.

110. Specimens for the Determination of Poisoning by Alcohol

In testing samples of blood for evidence of alcohol poisoning, it has been found that a sample from the heart may give a falsely high value since after death alcohol may be absorbed directly from the stomach by continguous organs. It has been suggested that blood from the femoral vein, portal vein, and the vena cava be used. Some toxicologists regard the level in spinal fluid as more reliable than that in blood. For method of obtaining spinal fluid see paragraph 46.

111. Supplies and Equipment

In addition to the usual instruments and equipment, a supply of glass-topped household preserving jars of the spring closure type, and wide and narrow mouthed glass-stoppered bottles of various sizes must be on hand in the autopsy room. These vessels should be thoroughly scrubbed with soap and hot water, rinsed, placed in bichromate sulfuric acid cleansing solution for several hours, rinsed thoroughly in tap water and distilled water, dried and stoppered. The use of plastic bags will be referred to in chapter 7.

112. Shipment of Specimens from Aircraft Accidents

a. In cases of Aircraft Accident Fatalities toxicological studies are performed at the Armed Forces Institute of Pathology in accordance with AFR 160–109 and BUMEDINST 6510.6. Although the presence of toxic substances may not be immediately suspected in aircraft accident victims, tissue should be forwarded to the AFIP for examination. Prompt collection of fresh tissue is essential, and it is imperative that no fixative come in contact with tissues for toxicological analysis. Refrigeration

TOXICOLOGICAL EXAMINATION - REQUEST AND REPORT

(Submit in Triplicate)

TO: The Director
Armed Forces Institute of Pathology
Washington 25, D. C.

FROM: Laboratory Service
Station Hospital
Ft. Bragg, North Carolina

SECTION A - MEDICAL REPORT

(If examining physician is other than recording authority, his signature must appear on this medical report)

1. NAME OF PATIENT (Last, first, middle initial)	2. SERVICE NUMBER	3. AGE	4. SEX	5. RACE
Anderson, Phillip P. A/2c	AF-86623010	18	M	Cau

EXAMINATION

6. HOUR	7. PLACE	8. DATE	9. TIME & DATE OF DEATH
1000	Laboratory Service, Ft. Bragg Station Hospital	5 July 1958	0400 hrs, 5 Jul 58

RECENT MEDICATION

10. PRESCRIBED OR ADMINISTERED
Thorazine

11. IN POSSESSION OF PATIENT
None

12. CONTAINERS FOUND IN PROXIMITY OF PATIENT
1 pint bottle gin, partly empty, in rear seat area of car

SPECIMEN COLLECTION — 13. HOUR AND DATE: 1200, 5 July 1958

SPECIMEN	AMOUNT	PRESERVATIVE (Freezing perferred)
14. Blood	500/cc	None
15. Spinal Fluid	10/cc	None
16. Liver	500/gm	Frozen
17. Kidney	150/gm	Frozen
18.		
19.		
20.		
21.		

22. SUMMARY OF EXAMINATION AND/OR AUTOPSY *(Include clinical history, any routine or special laboratory tests performed, and other pertinent information which may suggest drug or poison ingestion)*

Airman found dead in front seat of his automobile on isolated secondary road. Windows of vehicle were partly closed. No external evidence of injury. Autopsy showed no specific cause of death on gross examination. There is a history of deceased being on Thorazine Medication for nervousness. Urine examination was negative for sugar and / for alcohol by qualitative study. Request analysis for CO, Alcohols, Thorazine.

23. DATE	24. NAME AND TITLE OF REQUESTER	25. SIGNATURE
5 July 1958	JOHN P. DOE, Capt, MC, Pathologist	/s/ John P. Doe

DD FORM 1 JUN 60 1323

Figure 19. Toxicological Examination—Request and Report.

SECTION B - CHAIN OF CUSTODY

(Each individual charged with custody of specimen must complete information below)

SIGNATURE	ORGANIZATION	HOUR	DATE	CONDITION OF SPECIMEN
26. Henry Smith	Laboratory Service Ft Bragg Station Hosp	1215	5 Jul 58	Frozen
27. Joseph Jackson	Department of Chemistry, 3rd AAML	1500	6 Jul 58	Frozen
28. L. Henninger	Department of Chemistry, 3rd AAML	0800	7 Jul 58	Frozen
29.				
30.				

SECTION C - TOXICOLOGY REPORT

31. LABORATORY	32. DATE	33. CASE NUMBER
Third U. S. Army Area Laboratory	7 Jul 1958	1086

LABORATORY ANALYSES

34. GASES Hydrogen Cyanide; Carbon Monoxide	Blood CO - % Saturation - Less 10%
35. VOLATILES Cyanide; Ether; Ethanol; Acetaldehyde; Methanol; Formaldehyde; Chloral Hydrate; Chloroform; Phenols and Cresols; Methyl Salicylate; Common Aromatic Hydrocarbons, (e.g. Benzene, Aniline, etc.)	Ethanol - Blood - 0.41% Sp. Fld. - 0.40% Methanol - None Found
36. ACIDIC COMPOUNDS Barbiturates; Salicylates; Dicoumarol; Acetanilid; Phenacitin; Antipyrine; Tri- and Di-Hydric Phenols; Theophylline; Caffeine	Blood Barbiturate - None Found
37. BASIC COMPOUNDS Alkaloids, Amphoteric Alkaloids, (i.e. Morphine and Morphine Derivatives); Antihistaminics; Tranquilizers	Thorazine - 25 Micrograms/100 ml blood
38. METALS AND METALLOIDS Antimony; Lead; Mercury; Silver; Bismuth; Arsenic	
39. CORROSIVES Sulfuric; Hydrochloric and Nitric Acids Sodium and Potassium Hydroxides and Carbonates	
40. INORGANIC NONMETALLIC COMPOUNDS Bromides, Fluorides, Borates	
41. SPECIAL ANALYSES Any analyses not included above which are specifically requested or warranted by case history	

42. REMARKS

Thorazine concentration is compatible with a Therapeutic level.

43. DATE COMPLETED	44. TOXICOLOGIST	45. OFFICER-IN-CHARGE
7 Jul 58	/s/ L. Henninger	/s/ F. E. Shideman, Major, MC

Figure 19—Continued.

is the prescribed method of preservation and dry ice has been a most satisfactory agent. If dry ice is not available, other means of refrigeration, such as salt water and ice, may be employed. Rapid transport is important and air express has proved to be the best means of shipment.

b. The tissue specimens for aircraft toxicological examination should consist of representative samples of the organs as outlined in BUMEDINST 6510.6; paragraph 8 AFR 160–109. Each tissue should be placed in a separate plastic bag (a federal stock item) and forwarded in a cardboard double mailing case (a federal stock item).

c. Each specimen container should be clearly identified and a summary of the evidence and gross findings (DD Form 1323) should also be inclosed in the shipment. Forward the package to: The Director, Armed Forces Institute of Pathology, Washington 25, D. C. and label: FRAGILE, RUSH, SPECIMEN FOR TOXICOLOGICAL EXAMINATION (AIRCRAFT ACCIDENT).

CHAPTER 6

SPECIAL EVIDENTIARY OBJECTIVES OF THE MEDICOLEGAL AUTOPSY

Section I. GENERAL PRECAUTIONS TO BE OBSERVED IN THE PERFORMANCE OF A MEDICOLEGAL AUTOPSY

113. Preliminary Investigation with Civil Authorities

a. Before he performs the autopsy the pathologist should confer with the police, the investigating authorities, or others having information about the case, in order that he can recognize all available evidence. It should be a standing rule that neither the clothing nor the surface of the body be disturbed until examined by the pathologist. In no circumstances should the body be embalmed before performance of a medicolegal autopsy.

b. In the event the pathologist cannot visit the scene he should request a written preliminary report on the circumstances surrounding death from the investigating authorities prior to performing the autopsy. Photographs of the scene where the body was found and the photographs made by the pathologist should be attached to the final autopsy report.

c. Restrict witnesses to the autopsy to those whose presence is required either by law or to assist the pathologist.

d. Disclose information regarding the autopsy findings only to those who have a legal right to it.

114. Evidence

a. Have photographs made of all potentially important evidence that can be recorded photographically. Photographs should be made in all medicolegal autopsies since they provide a valuable objective record.

b. Prepare detailed descriptions, diagrams, and measurements of all wounds or recent disturbance of the clothing or to the surface of the body.

c. A medicolegal autopsy should never be a partial autopsy and should always include the brain, spinal cord, and organs of the neck. X-ray examination of the extremities and vertebral column is essential if there is a reasonable chance that these structures may have sustained injury. The neck organs should always be examined since sudden death by suffocation can result from the presence of foreign bodies, particularly food, or fractures of the thyroid or cricoid cartilages.

d. Label all specimens removed from the body for further examination. Do not permit any interruptions in the continuity of custody of the specimens.

e. Blood for group determination should be taken routinely in deaths by violence in which blood has been shed. Blood and/or cerebrospinal fluid should be taken routinely for alcohol determination in all deaths from violence or unexplained causes.

f. Confine the historical part of the autopsy record to one section, the objective or factual part to another, and the interpretative or diagnostic to still another. Do not confuse what you have been told with what you have seen or with your opinions or diagnosis. The objective or factual part of the report should be prepared in such detail and clarity that the reader can form his own opinion of its significance. If any of your opinions or diagnoses are based to any degree on information supplied to you by others, this fact should be indicated in the report.

g. The medicolegal protocol must be correct in all dates, weights, measurements, and in spelling. The inch-pound measurements are preferable to the centimeter-gram. A single error lays the entire protocol open to the criticism of carelessness and may discredit the autopsy examination.

Section II. SPECIAL PURPOSES AND PROBLEMS

115. Objectives

The medicolegal autopsy has the special purpose of securing information needed for the administration of justice, even though such information is irrelevant by ordinary medical standards.

116. Special Problems

Some of the special problems of a medicolegal autopsy are the following:

a. Are the Remains of Animal or Human Origin? The remains may be so fragmentary or so extensively altered by post-mortem change that it is not immediately apparent whether they are human or animal.

(1) If putrefactive changes are not too advanced the distinction can be made by means of the precipitin test. Specific antisera are available not only for distinguishing between materials of animal and human origin, but also for identifying the kind of animal from which the material was derived.

(2) If the material to be identified includes any part of the bony skeleton, consultation with an anatomist, anthropologist, or roentgenologist will almost invariably establish or exclude human origin. The distinction between animal and human osseous tissue may be made by microscopic examination of a small fragment of bone. There are methods by which it is often possible to decide between animal or human origin of so small a trace as a single hair.

(3) No matter how mutilated, decomposed, or burned the remains may be, it is highly probable that a complete and careful examination of them will yield information of medicolegal importance.

b. The Identity of the Corpse.

(1) The medical investigator is responsible for arrangements for the taking of photographs and finger prints in all instances in which identity is in doubt. If by reason of mutilation or putrefaction personal identity cannot be established by ordinary means, the investigator must procure all information which might conceivably be useful for this purpose.

(2) Evidence of sex, stature, age, and various inherent or acquired individual peculiarities may be obtained from the skeleton alone in the event that the evidence needed is not available from the soft tissues. Thus, the contour of the pelvis or skull of an adult usually makes it possible to recognize whether the remains are those of a male or female.

(3) When identification of a body or parts of a body is unusually difficult, or when multiple detached parts of several bodies present a problem, technical specialists are available to give aid as indicated in AR 638–42; BUMEDINST 5360.19; NAVMC 1129; and AFR 143–3. "When technical specialists are required to help in identification (in addition to those available in an area), field commanders will request certain designated headquarters, through channels, to furnish assistance. For example, an Army commander will request this assistance from the Quartermaster General; a Naval commander from the Bureau of Medicine and Surgery; or the Commandant of the Marine Corps and an Air Force commander from Air Materiel Command."

(4) Stature can be estimated with reasonable accuracy if the length of any one of the long bones of the extremities is known. Many skeletal features, including condition of the teeth, presence or absence of ossification centers, ossification of the cartilaginous plates between the epiphyses and diaphyses, closure of the endocranial sutures and presence of certain porotic or proliferative changes in the bones may provide information as to the age of the deceased. X-ray examination of an unidentified body may be useful for reasons other than disclosure of age. A large proportion of the adult population has had roentgenological ex-

amination at one time or another. That the remains are those of a given missing person may be proved by comparison of post-mortem X-rays with those taken during life. In addition, X-ray studies may disclose evidence of bullets or other foreign bodies that might otherwise be overlooked.

(5) Evidence pertaining to identity of decomposed or mutilated remains is not confined to the skeleton. Surgical scars, healed fractures, disease processes may help to confirm or exclude the corpse as that of any specified missing person. Information as to the foods eaten at the last meal may prove of value in establishing identity.

c. Time of Death. All available sources of information should be utilized in determining the time of death. Knowledge of the time of death of a victim of homicide may prove that a given suspect could or could not be guilty. Three sources of information ordinarily relied upon are:

(1) *Witnesses.* Statements from witnesses who claim to have been present at the time of death, to have last seen the decedent alive or to have first seen the dead body. Such information may or may not be reliable and should never be depended upon to the exclusion of other sources of information.

(2) *Rate processes.* An approximation of the time of death can usually be made on a basis of knowledge of the length of time required for the onset or completion of any one or a combination of post-mortem changes. It is known that the temperature of a corpse tends to come into equilibrium with the temperature of its environment. Although the rate of this change is affected by many factors, the duration of the post-mortem interval may often be approximated by estimating the rate at which the body probably cooled. The factors which should be taken into consideration in making such an estimate include the size and state of nutrition of the body, whether it is nude or clothed and whether the environment is cold or warm. Measurements of the superficial and internal temperature of the body and the environmental temperature should be recorded. Other post-mortem changes which occur at more or less predictable rates include livor mortis, rigor mortis, and the stage of putrefaction. The autopsy protocol should include a detailed account of all such post-mortem changes.

(3) *Associated events.* The time of death may be established in relation to certain other events which took place at a known time. For instance, if the ground under the body was dry even though rain had been falling for six hours when the body was found, the inference is that death had occurred before the rain started to fall. If an evening meal known to have been eaten by the decedent was found undigested in his stomach at autopsy, the inference is that death probably occurred before midnight. The number and kinds of associated events that may be useful in determining the time of death is infinite and their recognition and utilization depend on the alertness and imagination of the pathologist.

d. Was the Fatal Injury Received at the Place in Which the Body Was Found?

(1) In the case of an unwitnessed death by violence it is likely to be of utmost importance to establish that the fatal injuries were or were not received at the place where the body was found.

(2) It may be obvious from the nature of the injuries that they could not have been inflicted without coincidental disturbances of the immediate surroundings. Injuries of such a nature as to indicate that death was preceded by a violent physical struggle would justify the assumption that they had been received elsewhere if the place in which the body was found was undisturbed. It may be apparent that the decedent bled from his wounds and if no blood is found at the place where the body was discovered, it can be assumed that the injuries were sustained at some other place. The distribution of livor mortis and rigor mortis should be

carefully ascertained to determine if it is consistent with the position or attitude of the body as found. When a person is found dead as the result of mechanical violence, the medical investigator should view the body and its environment before either has been disturbed.

e. Can the Probable Circumstances in Which the Fatal Injuries Were received be Reconstructed by Examination of the Body and the Place Where it was Found?

(1) The distribution and character of blood drops or smears may be helpful in distinguishing between accident and assault. It may be of great importance to establish the direction from which the fatal injury was received. Thus, a wound of one type may be consistent with accident, whereas a wound of another type may provide clear evidence of assault. A wound in one location may be compatible with the defendant's plea that he acted in self-defense, whereas a wound in another may render such an allegation untenable. A single injury may be compatible with accident, whereas multiple injuries may in some circumstances be clearly indicative of deliberate assault.

(2) The character of the place where the body was found may indicate that the injuries were accidental or probably the result of assault. Thus, multiple injuries of a person found dead at the bottom of a ravine or on a highway may be consistent with death by accident, whereas the same injuries on a body found on the soft earth of a field could not be the result of an accident at that place.

(3) The nature and location of injuries are often the means of distinguishing between suicide and homicide. This is particularly true in the case of firearm injuries. In the study of fatal injuries of this kind, wounds of entrance must be distinguished from wounds of exit and the characteristics of the region of the entrance wound described in detail, for these indicate the distance between muzzle and target when the fatal shot was fired. Fouling of the disrupted tissues immediately beneath the entrance wound by powder residues indicates that the muzzle was in contact with the target at the moment of fire. Superficial fouling of the target by powder residues indicates that the muzzle was relatively close to the target. The shorter the distance between muzzle and target the greater will be the tendency for the combustion residues to be concentrated in the immediate vicinity of the entrance wound. Rarely will combustion products be deposited on the surface of the target if range of fire is greater than eighteen inches. In cases of fatal injury by close range rifle or shotgun fire in which the question of suicide may be raised, two measurements should be made: The distance between the entrance wound and the trigger when the muzzle is placed against the wound, and the distance between the entrance wound and the forefinger of the extended hand. Such measurements will usually reveal whether the wound could have been self-inflicted. However, in certain instances of suicide the individual has been known to have used his toe or some external object in order to pull the trigger.

f. Is There Evidence of a Special Predisposition of the Deceased to Accidental or Suicidal Injury or to Assault?

(1) A rich source of information relating to special susceptibility to injury is provided by chemical examination of the blood, spinal fluid, or brain of the decedent for alcohol. A concentration indicative of acute alcoholism may make plausible an otherwise inexplicable accident. Acute alcoholism may account for suicidal dementia or for behavior changes likely to provoke assault.

(2) The presence of any one of a number of diseases which would predispose to unexpected collapse or to impairment of the normal protective mechanisms might serve to explain an otherwise obscure accident.

g. Is there Objective Evidence Relating to Time Elapsed Between Injury and Death? It may be of utmost importance from a medicolegal standpoint to establish as accurately as possible the interval between injury and death. Injury is usually followed by an orderly sequence of reactive changes, and a recognition of these may make it possible to estimate the time that has elapsed. Thus, microscopic examination of the injured tissues may show that a given injury could not have been sustained more than a few minutes before death or that injury was sustained hours, days, or weeks before death. The establishment of the civil or criminal responsibility of some individual may depend to a large degree upon the amount of care that has been exercised in the acquisition of such information. The circumstances may be such that a given individual could or could not be responsible for the fatal injury, if it were known that it was received before or after some specified time.

h. If There are Multiple Injuries, in What Sequence Were They Received? It is important not only to determine the interval between injury and death, but also to reconstruct the sequence in which any given series of injuries was received. In cases of multiple injuries, it may be found that certain wounds were received after others, some may even have been inflicted after death. In such instances it may be apparent that suicide or a plea of acting in self-defense is untenable. In other instances it may be found that the injuries were separated by hours or even days. If such injuries have resulted from assault, there may be clear evidence of premeditation and extreme cruelty.

i. Is There Evidence That More than One Assailant Participated in the Attack, and if so, What Injuries Can Be Attributed to Each? It is frequently impossible to determine whether one or several assailants participated in a given assault. Such a determination can be made, however, in many instances of homicide by shooting. If examination discloses that the injuries were inflicted by several different weapons as indicated by the character of the wounds or differences in bullets, it may sometimes be assumed that several persons participated in the attack. It is important not only that this fact be recognized but also that a detailed description be made of the extent and nature of the injuries produced by each assailant.

j. Were the Injuries Immediately Incapacitating and if not, to What Extent and for How Long Was the Deceased Capable of Movement?

(1) It is important to interpret certain facts to determine the extent to which the decedent may have contributed to their existence. In such circumstances it may be important to know what he might have done after certain injuries were sustained. If he could not have come unaided to the place where his body was found, it can be assumed that someone is in possession of special knowledge regarding the circumstances in which the injury was received.

(2) The distribution of blood stains may indicate considerable movement on the part of a wounded person. If the decedent was injured in a manner incompatible with further locomotion, it may be apparent that his assailant was also wounded.

k. Did the Assailant Leave Anything in or on the Body of the Victim that Might Assist in His Identification?

(1) Whenever one person injures another by means of physical violence it is probable that the assailant will leave something in or on the body of the injured person that will aid in the apprehension of the criminal. The most satisfactory evidence in this respect is provided by the finding of a bullet in the body of the dead person. A bullet frequently bears markings characteristic of the firearm from which it was discharged. Even though the bullet is not available, it may have left metallic traces in the skin or tissues by which its composition can be determined. If the bullet was fired from close range (under 18 inches), chemical or metallic residues are likely to be present on the skin or clothing of the wounded person. A bullet found in a body at autopsy should not be handled with forceps because of the introduction of artefactitious markings. Examination of residues may disclose not only the range of fire but also the nature of the ammunition that was used. In the absence of the bullet, the

ejected shell case may provide valuable evidence as to the identity of the weapon.

(2) Wounds should be examined before the body is moved, and if it is apparent from the entrance wound that the bullet was jacketed and probably from an automatic pistol, a search should be made for the empty shell case before the body is moved. A marginally soiled entrance wound may constitute presumptive evidence that the bullet was fired from a revolver, whereas a clean entrance wound sometimes indicates that the bullet was fired from an automatic pistol or a rifle. Tissue for histopathological examination should be taken from the entrance wound.

(3) The shape or configuration of wounds may reveal the type of instrument used in their production. Thus, the pattern of an automobile tire or radiator grill may be imprinted on clothing or skin. Wounds produced by a given type of hammer, wrench, file, etc., may have highly individual characteristics. Such injuries should be photographed before and after the clothing has been removed and before and after the skin has been washed. Such photographs should either be of actual size or should be taken with a ruler laid close to the area being pictured.

(4) If there is evidence that the victim and his assailant engaged in a struggle, the latter may have been wounded and tests may disclose not only the blood group of the victim but also a different blood group of the assailant. Hairs of the assailant may be found in the hand of the dead person and abraded epidermis of the assailant may be found beneath the dead person's fingernails. In cases of fatal sexual attack in which rape has preceded or been coincident with murder, information useful in establishing the identity of the assailant may be obtained by testing the seminal fluid found on the person or clothing of the decedent. It may be possible to determine the blood group to which the assailant belongs even though the seminal stains are old and dry.

k. Is it Likely that Recognizable Traces of the Victim were Carried Away in or on the Person of the Assailant? It should be a routine procedure to determine the blood group of the victim of any kind of mechanical injury in which there is a possibility that blood from the decedent was transferred to the person of the assailant or to a weapon or instrument which the assailant may have taken from the scene of the attack. The finding on the clothing or on some article in the possession of a suspect of human blood to that of the deceased and unlike that of the suspect provides presumptive evidence either of guilt or incriminating knowledge.

CHAPTER 7

SELECTION AND PRESERVATION OF TISSUE FOR FURTHER STUDY AND MUSEUM PURPOSES

Section I. FIXATION OF BLOCKS FOR MICROSCOPIC STUDY

117. Selection of Tissue

Blocks of tissue to be used for microscopic study should be selected as follows:

a. Tissue should not be crushed or otherwise injured before it is selected and cut from the organs. The mucosa of the intestine should not be touched or washed before the block is taken. Contact of any tissue with water should be avoided before fixation.

b. Use adequate amounts of fixative. Twenty volumes of fluid for each one volume of tissue is recommended.

c. If there is a focal lesion, the block should be taken to include the junction of the lesion with the normal tissue.

d. The block should be sufficiently thin to allow rapid penetration of the fixative—*not over 0.5 cm. in thickness.*

e. Ample tissues should be taken for microscopic study and more than one block from significant areas. The blocks should be sufficiently large for orientation and identification of the parts of the organ—ordinarily not less than 1.5 to 3 cm. square.

f. Sections of each organ should be taken through representative structures; for example, blocks from the kidney should include the cortex, medula, and pelvis; blocks from the intestine should include a lymphoid follicle; blocks from the heart should include ventricles, atria, valves, and coronary arteries.

g. In organs covered by a serious membrane at least one block should include the serosa.

h. If there is any question of identification (sections from the base and tip of the appendix, from each of paired organs, or from the various lobes of the lung), each block should be placed in a separate bottle or cut in a distinctive shape, so that they can be identified later.

i. Make certain that the tissue is not bent, twisted, or distorted after it is placed in the fixative. Small pieces of tissue may be placed on a paper towel and then floated into the fixative. There is sufficient protein on the surface of most organs to coagulate and hold the tissue to the paper.

j. Over-fixation in some fixatives may do much harm. Tissue should never be fixed in Zenker's fluid for longer than 18–24 hours. Most tissue is adequately fixed at the end of 12 hours.

118. Fixation

a. Ten percent formalin: fix for 24 to 48 hours, wash briefly in water and place again in 10 percent formalin.

b. Zenker's fluid: fix for 18 to 24 hours, wash for 24 hours in running water and then place in 70 percent alcohol.

c. Bouin's fluid: fix for 24 to 48 hours, place in 70 percent alcohol and change the alcohol every 24 hours until there is no further leaching of the picric acid into the alcohol.

d. Regaud's fluid: fix for 24 to 48 hours. The tissue should be washed for 24 hours in running water and then placed in 70 percent alcohol.

119. Formulae for Fixatives

a. Formalin. This is the best fixative for general purposes. It is prepared by mixing one volume commercial formalin (37–40 percent formaldehyde solution) with nine volumes of tap water. The 10 percent formalin (3.7–4.0 percent formaldehyde solution) should be neutralized and buffered (pH 7.0) by the addition of 4 gm. acid sodium phosphate monohydrate and 6.5 gm. anhydrous disodium phosphate *per liter.* If the chemicals are not available, neutralization can be accomplished by adding a sufficient amount of precipitated calcium carbonate or finely divided marble to make a layer 1 to 2 cm. deep at the bottom of the container.

b. Ethyl Alcohol. This should be used only for special purposes. For fixation and prolonged storage of tissues for glycogen stains,

use absolute alcohol. For certain cytological studies of the central nervous system, use 95 percent alcohol. When formalin is not available, 95 percent ethyl alcohol may be used if the tissue sections are cut less than 0.3 cm. thick.

c. Zenker's Fluid.

Potassium bichromate	2.5 gm.
Mercuric chloride	5.0 gm.
Distilled water	100.0 cc.

At the time of use, add 5 cc. glacial acetic acid to 95 cc. of the above mixture. If mercuric chloride is not available, 2.5 gm. zinc chloride may be substituted. For fixation of bone marrow, in which there are spicules of bone, add 10 cc. glacial acetic acid to 90 cc. of the above solution to facilitate decalcification.

d. Bouin's Fluid.

Glacial acetic acid	5 cc.
Commercial formalin	25 cc.
Picric acid, saturated aqueous solution	75 cc.

e. Regaud's Fluid. This fixative is recommended for all tissues in which demonstation of Rickettsia is to be attempted.

Potassium bichromate, 3% aqueous solution	80 cc.
Commercial formalin	20 cc.

After fixation for 24 to 48 hours, wash in running water and store in 70 percent alcohol.

Section II. PRESERVATION BY DEEP FREEZING FOR BACTERIOLOGICAL, SEROLOGICAL, AND HORMONE STUDY

120. Methods of Preservation and Storage

a. Tissue, fluid, or feces can be stored in a frozen state pending future examination for microorganisms, hormone assay, or serological reactions. Virus recovery is most successful if the material has been kept at −60° C to −70° C. The autopsy should be performed promptly so that the material will be fresh.

b. Tissue or fluid in 1 cc. amounts should be obtained under sterile conditions and each sample placed in a separate, labeled, wide-mouthed bottle; representative pieces of adjacent tissue should be fixed for histological study.

c. Blood serum may be collected by withdrawing 10 cc. of blood in a sterile dry syringe, and transferring it to a sterile centrifuge tube. After clotting, the blood is centrifuged, serum withdrawn and transferred to a sterile Wasserman tube and sealed with a rubber sleeve-type stopper. The tube should be frozen in an inclined position.

121. Hormonal Study

If hormonal study is the objective, the autopsy should be performed immediately. The organ to be studied should be weighed in its entirety and blocks selected for histologic study. The remainder, or a large portion of the organ, should be frozen and maintained at −20° C. Analysis should be carried out promptly.

Section III. PRESERVATION OF TISSUES FOR MUSEUM PURPOSES

122. Objective

In the selection and preparation of a specimen for display in a museum, the prosector should bear in mind that the tissue is to be viewed by others who do not have the advantage of inspecting the entire organ and other organs.

123. General Principles

The following general principles are suggested as a guide:

a. The specimen should have one flat surface, cut with one stroke of a large knife.

b. The specimen should not be thicker than 2 to 3 cm., as fixative will not penetrate beyond a few centimeters. With large organs, fix half of the organ and then cut the slab to include the original cut surface.

c. With large solid viscera, two parallel surfaces should be prepared, each by a single stroke of the knife.

d. Cut the organ in such a way that orientation is possible.

e. Do not cut a new surface after fixation except as mentioned in *b* above, for the characteristic contour may be lost.

f. Place the specimen in the fixative so that it is not distorted.

g. Do not cover specimens with paper towels, because these will leave an imprint of the towel's fibers. If the tissue floats, cover it with a layer of absorbent cotton, the fibers of which,

by capillary attraction, will draw fluid over the exposed surface. Cover the container lightly.

h. Opened hollow viscera may be pinned on a board, using care to avoid tension which produces distortion.

i. Be sure that the specimen does not adhere to the sides or bottom of the vessel, preventing contact of the fixative with all surfaces.

j. Label each specimen. The most satisfactory method is to print the identifying number on linen cloth with India ink, dip the cloth in melted paraffin, and after cooling, sew the label to the specimen.

124. Special Instructions Regarding Members of the U. S. Military Academy Class of 1956

a. The U.S. Military Academy, class of 1956, has been the subject of much research and study regarding the relationship of blood lipo proteins in cardiovascular study. This study embraces about 475 subjects, and it is intended that it will continue for 20 or more years, and it should provide information regarding the relationship of lipo proteins, cholesterol, and phospholipids to the occurrence of atherosclerotic heart disease.

b. Much clinical data has already accumulated on these individuals. It is essential that in case of death in any one of these individuals, that a very careful post-mortem examination should be performed. The autopsy investigation is very important, and it is essential to the successful completion of this study. If the examination is incomplete, or there is failure to carry out these instructions, it means that the chance for a correlation of a large amount of clinical data, with the post-mortem findings, is lost forever.

c. These cases are identified by a special folder in their health records. In such cases, it is essential that the heart and the aorta be opened in the usual way and maintained intact. The specimen should be fixed in neutral formalin using approximately 10 times the amount of tissue mass. The formaldehyde should be changed in the first few hours, and every effort made to insure proper fixation. A routine section of the myocardium should be taken. The specimen should be packaged in a separate container and sent with the remaining autopsy specimens to the Armed Forces Institute of Pathology, ATTN: Cardiovascular Pathology Section, Washington 25, D. C. This applies to only those cases under study and embracing the U.S. Military Academy, class of 1956.

d. A careful evaluation of the blood vessels, other than those of the heart and aorta, should be made at the time of post-mortem examination. Specimens should be taken from vessels showing significant pathologic changes, and these specimens should be appropriately labeled and identified.

e. The success of this investigation embracing years of clinical work is dependent upon careful anatomical study and the proper collection and securing of specimens.

Section IV. FIXATION OF MUSEUM SPECIMENS

125. Methods and Solutions

Formaldehyde converts hemoglobin to acid hematin, thus causing loss of characteristic color. The following methods will aid in preservation of color:

a. The Kaiserling Method. The tissue is fixed in a solution designated as Kaiserling I, made as follows:

Potassium acetate	170 gm.
Potassium nitrate	90 gm.
Commercial formalin	1,600 cc.
Water—sufficient to make	8,000 cc.

After 3 to 7 days, the specimen is washed in running water from 12 to 24 hours and then placed in 95 percent ethyl alcohol, referred to as Kaiserling II. Alcohol converts the brown acid hematin into reddish brown alkaline hematin. The specimens should be kept under observation in alcohol from 6 to 24 hours, until there is maximum development of the reddish color. If ethyl alcohol is not available, tertiary butyl alcohol may be substituted. Remove the specimens from the alcohol, wash in running water for not over 2 hours, and place in the final mounting fluid, known as Kaiserling III, made as follows:

Potassium acetate	1,720 gm.
Glycerol	2,000 cc.
Water—sufficient to make	10,000 cc.

As a preservative, add to the above, 20 cc. of phenol or crystals of thymol until the solution is saturated. If phenol or thymol is not avail-

able, arsenious acid 4 percent (poison), or sodium fluoride 8 percent (poison), may be substituted, and the potassium acetate reduced to a concentration of 2 percent. If glycerol is not available, propylene glycol is a satifactory substitute.

b. The Klotz Method:

Klotz I Solution

Sodium sulfate	385.0 gm.
Sodium bicarbonate	351.0 gm.
Sodium chloride	317.0 gm.
Potassium nitrate	657.0 gm.
Potassium sulfate	45.0 gm.
Chloral hydrate	1750.0 ml.
Formalin	1750 ml.
Distilled water—sufficient to make	35,000.0 ml.

Klotz II Solution

Sodium sulfate	193.0 gm.
Sodium bicarbonate	175.0 gm.
Sodium chloride	159.0 gm.
Potassium nitrate	328.0 gm.
Potassium sulfate	23.0 gm.
Chloral hydrate	350.0 gm.
Formalin	175.0 ml.
Distilled water—sufficient to make	35,000.0 ml.

Procedure:

Fix specimen for 1 to 5 days in Klotz I.

Wash in running water for 24 hours.

Place in several changes of Klotz II over a period of several weeks, or until the solution remains clear.

Mount in Klotz Solution II.

c. Solution for Use with Plastic Mounts:

(1) The wet mount in plastic permits better retention of color than any other gross mounting technique. Satisfactory fixation can be obtained with the hydrosulfite technique. (Bulletin of the International Association of Medical Museums, *32*:117, 1951).

Solution for Tissue Fixation

Sodium phosphate, monobasic (a buffer)	89.1 gm.
Sodium phosphate, diabasic (a buffer)	112.5 gm.
Formaldehyde solution (40%) (5% in final solution).	950 cc.
Distilled water—sufficient to make	19,000 cc.

Solution for Color Restoration

First three components, same as above	
Sodium hydrosulfite	95.0 gm.
Distilled water—sufficient to make	19,000.0 cc.

(2) Procedure: The gross specimen should be fixed in the first solution for a minimum of 2 weeks, preferably 3 to 4 weeks. Precautions should be taken, including covering the bottom of the container with cotton to insure contact of the solution with all surfaces.

126. Remarks

a. If primary fixation is defective (because of inadequate time or incomplete contact with solution) the color of the poorly fixed tissue will not be restored by the final mounting solution and the mounting fluid will become cloudy. Perfusion should be done when possible.

b. Attempt color restoration only with properly fixed specimens. If the specimen is fixed in 10 percent unbuffered formalin, the longer the specimen remains in the formalin solution, the poorer are the possibilities of restoring color.

c. Hydrosulfite restores reds as brighter hues than the Kaiserling technique.

d. Hydrosulfite deteriorates rapidly if exposed to air and the stock solution tends to deteriorate after 10 days.

e. Sections for histologic study can be taken from tissue fixed in the first solution, but fixation may take 2 to 4 times as long as 10 percent formalin.

f. After the hydrosulfite has restored the color, subsequent exposure to air will cause permanent fading. This means that the solution cannot be used in glass containers in which there must be a large air space. It also explains why all bubbles must be removed and the hydrosulfite solution introduced only when the box is to be permanently sealed.

g. Because of the danger of color loss, special precautions should be taken in changing the hydrosulfite solution if it becomes cloudy. The simplest way is to introduce the fluid through a narrow tube and withdraw it through another tube at the same time, keeping the overall level of fluid constant.

h. To minimize the possibility of cloudy solutions, friable specimens may be coated with gelatin.

i. The mount should be viewed by incandescent rather than fluorescent light, for the fluorescent spectrum does not possess the reds and oranges necessary to impart "natural" color.

j. Melanin and bile pigment usually discolor the mounting solution.

k. The hydrosulfite is somewhat difficult to

get into solution and may cause the fluid to be cloudy for several hours.

l. When a specimen is sent to a central museum, make a note on the jar and in the protocol of the exact procedure used for fixation, restoration of color, and final preservation.

m. Some laboratories will find it more convenient to ship the specimens, after primary fixation, to the central museum, where color restoration will be carried out.

Section V. PHOTOGRAPHY

127. Use

a. Photographs are a useful adjunct to museum specimens for teaching purposes and have other advantages. Although photographs in color are decidedly superior to the "black and white," the latter are still widely and successfully utilized.

b. Photos of the entire body, including the clothing are often valuable in medicolegal cases. Details of wounds, skull fractures and other lesions may be recorded accurately by photography. The background should be as free as possible from extraneous objects, and should have contrast with the specimen. Each photograph should show the autopsy number for purposes of identification. Slender arrows cut from paper, or wooden applicator sticks judiciously used, aid in calling attention to a lesion. A ruler or scale should always be included. It is important to keep identifying number, ruler, and arrows out of contact with the specimen. They should be so placed that they can be blocked out if desired when a print is made.

CHAPTER 8

COLLECTION OF DATA, SHIPMENT OF SPECIMENS FOR DIAGNOSIS, STORAGE, AND MEDICAL MUSEUM

Section I. PREPARATION AND SHIPMENT OF SPECIMENS FOR DIAGNOSIS

128. General Instructions

a. Wet tissue specimen should be prepared in accordance with directions given in chapter 7 before they are shipped. After fixation, the specimen should be placed in fresh solution before it is packed.

b. The availability of materials determines the method of packing wet specimens, but polyethylene plastic bags are recommended for this purpose (ch. 7).

c. The fixed specimen should be placed in a cotton bag of appropriate size or wrapped in gauze and a durable tag attached to the outside of the wrapping. This tag must contain the name of the contributing activity, autopsy number, year, and patient's name.

d. The wrapped and tagged specimen should be placed in a plastic bag, containing sufficient fixative to saturate the bottom bag or gauze wrapper. *Evacuate as much air as possible* from the plastic bag and heat-seal or twist and secure with a rubber band or scotch tape. Each bag should be tested to insure absence of leaks.

129. Individual Specimens

Small individual specimens, each in its plastic bag, may be mailed in a single "container assembly." In order to protect the specimens, place some cotton in the base of the inner container, insert the sealed plastic specimens and add more cotton at the top to fill the container. The protocol folder should be wrapped around the container and held in place with a rubber band. The complete unit should be inserted in the mailing section of the assembly. The label should be marked *First Class Mail, Rush, Specimen for Diagnosis;* addressed; and mailed. The pathologist should familarize himself with the postal regulations concerning the shipment of diseased tissue.

130. Groups of Specimens

Large groups of specimens, individually packed, may be shipped in one container, provided sufficient padding is used. Protocols and contributor's lists should be included, placed in a separate plastic bag which has been heat-sealed or twisted and secured with a rubber band. The plastic bag will protect the protocols from damage by preservatives in the event of an accident during transit. Enclose the protocols in the packing box which should be sealed, labeled *Fragile, Laboratory Specimens,* addressed and shipped.

131. Containers

a. Should glass jars or metal cans be used as specimen containers, place cotton, saturated with fixative, in the bottom of each container; then insert the tagged specimen. The container should be labeled with the name of the contributing activity, autopsy number, year, name of patient and preservative used.

b. The shipping container for wet tissue should never exceed 8 cubic feet (2′ x 2′ x 2′) nor should it weigh more than 50 pounds.

c. It is desirable, when processing autopsy material for shipment, to send slides and tissue blocks in one container and wet tissue in another.

132. Armed Forces Specimens

The Armed Forces specimens should be prepared and forwarded in accordance with AR 40–31, BUMEDINST 6510.2A, AFR 160–55, and changes thereto (app. I).

Section II. PREPARATION OF SPECIMENS FOR SHIPMENT TO ARMED FORCES INSTITUTE OF PATHOLOGY MEDICAL MUSEUM

133. Fixation

a. Specimens intended primarily for Museum purposes should be fixed in one of the color preserving solutions described in paragraph 125.

b. The precautions applicable to gross tissue fixation should be followed, such as filling of hollow organs with cotton and avoidance of mutilation of specimens.

134. Containers

Glass containers, if large enough to contain the specimen without distortion, are adequate for shipping specimens and can be well sealed. Forcing the specimens into inadequate bottles will lead to irreversible distortion. Polyethylene plastic bags are permissable if the specimen is kept moist and free from distortion.

APPENDIX I

REFERENCES

Joint Army, Navy, and Air Force Directives:

AR 15–97 BUMEDINST 6510.6 AFR 160–127	Joint Committee on Aviation Pathology.
AR 40–29 BUMEDINST 6510.1B AFR 160–38	Armed Forces Institute of Pathology.
AR 40–31 BUMEDINST 6510.2A AFR 160–55	Central Facilities Provided for Department of Defense Armed Forces Institute of Pathology and Histopathology Centers.
AR 40–441 BUMEDINST 6200.1 AFR 160–62	Joint Utilization of Certain Armed Forces Medical Laboratory Facilities.
AR 638–42 BUMEDINST 5360.19 NAVMC 1129 AFR 143–3	Care and Disposition of Remains When Multiple Deaths of Members of Two or More Services Occur as a Result of Disaster or Major Accident.
FM 10–63 NAVMED P–5016 AFM 143–3	Handling of Deceased Personnel in Theaters of Operations.

Army Directives:

AR 40–200	General Administration of Medical Treatment Facilities, Death & Preparation of Remains.
AR 385–40	Accident Reporting and Records.
AR 600–65	Casualties.
AR 600–140	Line-of-Duty Determinations.
AR 638–30	Graves Registration Organization and Functions in Support of Major Military Operations.
AR 638–40	Policies and Responsibilities for Care and Disposition of Remains.
AR 638–45	Procedures of Care and Disposition of Remains.
TB AVN–8	Aircraft Accident Investigations.

Navy Directives:

Manual of Medical Department:

Chapter 17	Deaths
Article 17–7	Reporting Deaths to Civilian Authorities.
Article 17–24	Post-Mortem Examinations and Autopsies.
Article 17–25	Relations with Civil Authorities.
BUMEDINSTR. 6510.6	Aviation Pathology Program.
OPNAVINST. 3750.6C	Navy Aircraft Accident, Incident, and Ground Accident Reporting Procedures.

Air Force Directives:

AFM 62–5	Aircraft Accident, Prevention — Investigation — Reporting.
AFR 62–14	Aircraft and Missile Accidents.
AFM 143–1	Mortuary Affairs.
AFM 160–20	Medical Treatment Facilities.
AFR 160–35	Administering Medical Treatment Facilities.
AFR 160–109	Medical Investigation of Aircraft Accident Fatalities
AFR 160–116	Histopathology Centers
AFR 35–67	Line-of-Duty and Misconduct Determinations and Investigations.

Acts and Amendments Concerning Jurisdiction over Military and Civilian Deaths:

(A.W. 113) SPJGA 013.35 (1942/3809), 21 August 1942, Bull. JAG 166.

SPJGA 1943/4937, 13 April 1943, II Bull. JAG 192 (1942).

JAG 013.2, 28 August 1918 (Dig. Op. JAG 1912–1940, Sec. 471), II Bull. JAG 192, 193.

Act of 4 June 1920, 4 Stat. 809, as amended by Act of 5 May 1950; 10 U.S.C. 1585, see pp. 453–454, MCM, 1951.

United States Code, Title 10 (page 809).

Miscellaneous Federal Publications:

Handbook 65, "Safe Handling of Bodies Containing Radioactive Isotopes." U. S. Department of Commerce, issued July 10, 1958.*

Manual of Histologic and Special Staining Technics. Armed Forces Institute of Pathology, Washington 25, D. C. 1957, pp. 194–195.

U.S. Department of Health, Education and Welfare, Public Health Service, National Office of Vital Statistics: Mortality from Each Cause: United States, 1953–55, Washington, D. C. Vital Statistics—Special Reports, National Summaries, No. 1, Vol. 46, (November 6) 1956.

U.S. Public Health Service: Physicians' Handbook on Death and Birth Registration, 10th Ed. Washington, D. C., U.S. Government Printing Office, 1949.

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* May be obtained from the Superintendent of Documents, Washington 25, D. C.

APPENDIX II

EQUIPMENT AND SUPPLIES

1. The autopsy room should have ventilation, light, good artificial illumination, and gas. In using artificial light, care should be taken that the colors are not misrendered. A sewer drain and tap water outlet to which a hose is attached should be available. The floor and walls should be made of material that is easily cleaned and washed.

2. The following instruments are recommended for the proper performance of an autopsy.

Standard items

Surgical Instrument Set, Post-mortem	ea 1
Chest, Medical Instrument and Supply Set, Field No. 3, 30 in. long by 18 in. wide by 10 in. deep, Empty.	ea 1
Knife, Craftsman's 5 in.	ea 1
Forceps, Tissue, Russian, 6 in.	ea 1
Chisel, Bone, 5 in.	ea 1
Forceps, Bone Cutting, Straight, Liston, 8¾ in.	ea 1
Ronguer, Curved, Hartmann, 7¼ in.	ea 1
Forceps, Dressing, Straight, Rankin, 5½ in.	ea 1
Forceps, Hemostatic, Straight, Rankin, 6¼ in.	ea 1
Forceps, Tissue, Tweezers Type, Straight, 5½ in.	ea 1
Mallet, Autopsy, Metal, with hook	ea 1
Blade, Surgical Knife, Detachable No. 21, 6s	Pkg 2
Handle, Surgical Knife, Detachable Blade No. 4	ea 2
Needle, Suture, Post-mortem, Half Curved, Cutting Edge, 5 in.	ea 1
Probe, General Operating, 10 in.	ea 1
Saw, Amputating, Satterlee, 8 in. blade	ea 1
Scissors, General Surgical, Straight, Mayo, 6¾ in.	ea 1
Scissors, Enterotomy, 8 in.	ea 1
Scissors, Iris, Angular, 4½ in.	ea 1
Scissors, General Surgical, Straight, 7 in.	ea 1
Scissors, General Surgical, Straight, Double Shape, 5¼ in. long, 1¾ in. cut	ea 1
Scales, Weighing, Commercial, Autopsy	ea 1
Rule, Anatomical, Transparent, 18 in.	ea 1
Knife, Slicing, Carbon Steel Blade, 16 in. long clear of Handle	ea 1
Saw, Bone-Cutting, Autopsy, Stryker, 110 volts, ac–dc, with one arbor, blade and electric cord	ea 1
Bag, cellophane, Pathological Specimen, Polyethylene lined, 4 x 6 in.	ea 1
Bag, cellophane, Pathological Specimen, Polyethylene lined, 6 x 8 in.	ea 1
Bag, cellophane, Pathological Specimen, Polyethylene lined, 8 x 10 in.	ea 1
Bag, cellophane, Pathological Specimen, Polyethylene lined, 12 x 10 in.	ea 1
Sealing Iron, Electric Pathological Specimen, Bag, 110 volts—600 cy.; ac, complete with cord	ea 1

Non-standard items

Chisel, Virchow, skull opening (for Autopsy Kit)	ea 1
Knife, post-mortem, full section, 18 in. cutting edge, hollow ground (for Autopsy Kit)	ea 1
Councilman's Bone Cutting Forceps, 15 in., Mortise lock	ea 1

APPENDIX III

TABLES OF AVERAGE WEIGHTS AND MEASUREMENTS

*Table I. Weight and Measurements of Various Organs in Adults**

Organ	*Weight in grams*	*Measurements in centimeters*	
Brain:			
Male	1100–1700 (average 1400)	Sagittal diameter, 15–17	
Female	1050–1550 (average 1275)	Vertical diameter, 12.5	
Spinal Cord	Average, 27	Length, 45	
		Frontal	*Sagittal*
Cervical		1.3–1.4	Average, 0.9
Thoracic		Average, 1	Average, 0.8
Lumbar		Average, 1.2	Average, 0.9
Pineal Gland	Average, 0.2		
Heart and Vessels:			
Male	270–360 (average 300)		
Female	200–280 (average 250)		
		Range	*Average*
Left ventricle muscle			1.5
Right ventricle muscle			0.5
Auricular muscle			0.2
Mitral valve		8–10.5	10.0
Aortic valve		6–7.5	7.5
Pulmonary valve		7–9	8.5
Tricuspid valve		10–12.5	12.0
Pulmonary artery			8.0
Aorta:			
Ascending			7.4
Thoracic			5.0
Abdominal			4.0
Lungs:			
Right	360–570 (average 450)		
Left	325–480 (average 375)		
Liver	1500–1800 (average 1650)	25–30 by 19–21 by 6–9	
Spleen:		12–14 by 8–9 by 3–4	
16–20 years	150–200 (average 170)		
20–65 years	Average, 155		
80 years and over	Average, 100		
Pancreas	60–135 (average 110)	23 by 4.5 by 3.8	
Kidneys:		11–12 by 5–6 by 3–4	
Male	230–440 (average 313)		
Female	240–350 (average 288)		
Prostate:		3.6 by 2.8 by 1.9	
20–30 years	Average, 15		
51–60 years	Average, 20		
51–80 years	Average, 40		
Seminal vesicles		4.1–4.5 by 1.6–1.8 by 0.9	
Uterus:			
Virgin	33–41 (average 35)	7.8–8.1 by 3.4–4.5 by 1.8–2.7	
After pregnancy	102–117 (average 110)	8.7–9.4 by 5.4–6.1 by 3.2–3.6	
Cervix (virgin)		2.9–3.4 by 2.5 by 1.6–2	
Endocrines:			
Pituitary:		2.1 by 1.4 by 0.5	
10–20 years	Average, 0.56		
20–70 years	Average, 0.61		
Pregnancy	0.84–1.06 (average, 0.95)		
Thyroid	30–70 (average, 40)	5–7 by 3–4 by 1.5–2.5	

* Table I is reprinted from Normal Values in Clinical Medicine, 1949 Edition, by permission of William F. Sunderman and Frederick Barner, the authors, and W. B. Saunders Company, Philadelphia and London, the publishers.

Table I. Weight and Measurements of Various Organs in Adults—Continued

Organ	*Weight in grams*	*Measurements in centimeters*
Testis:		
Newborn		1 by 0.5 by 0.4
Puberty		3 by 2 by 1.6
Adult	20–27 (average 25)	4–5 by 2.5–3.5 by 2–2.7
Ovary:		
Virgin		4.1–5.2 by 2–2.7 by 1–1.1
After pregnancy	Average, 7	2.7–4.1 by 1.5 by 0.8
Adrenal	Average, 6	4.5 by 2.5–3.5 by 0.5
Parathyroids	0.12–0.18	0.3–0.6 by 0.2–0.4 by 0.05–0.2 (ea)
Thymus:		
Newborn	6.05–25.88 (average 13.98)	
1–9 months	6.74–34.10 (average 20.14)	
9–24 months	19.97–37.72 (average 26.60)	
6–25 years	Average, 25	
26–35 years	Average, 20	
36–65 years	Average, 16	
65 years and over	Average, 6	
Gastrointestinal tract:		
Esophagus		25
Duodenum		30
Small intestine		550–650
Colon		150–170

*Table II. Average Weights and Measurements of Normal Organs** *(Infants and Children)*

Age	Body weight M**	Body length	Heart	Lungs		Spleen	Liver	Kidneys		Brain
				right	left			right	left	
	kg	*cm*	*gm*	*gm*	*gm*	*gm*	*gm*	*gm*	*gm*	*gm*
Birth—3 days	3.4	49	17	21	18	8	78	13	14	335
3—7 days		49	18	24	22	9	96	14	14	358
1—3 weeks		52	19	29	26	10	123	15	15	382
3—5 weeks		52	20	31	27	12	127	16	16	413
5—7 weeks		53	21	32	28	13	133	19	18	422
7—9 weeks		55	23	32	29	13	136	19	18	489
3 months	6.5	56	23	35	30	14	140	20	19	516
4 months		59	27	37	33	16	160	22	21	540
5 months		61	29	38	35	16	188	25	25	644
6 months	8.5	62	31	42	39	17	200	26	25	660
7 months		65	34	49	41	19	227	30	30	691
8 months		65	37	52	45	20	254	31	30	714
9 months	9.8	67	37	53	47	20	260	31	30	750
10 months		69	39	54	51	22	274	32	31	809
11 months		70	40	59	53	25	277	34	33	852
12 months	10.8	73	44	64	57	26	288	36	35	925
14 months		74	45	66	60	26	304	36	35	944
16 months		77	48	72	64	28	331	39	39	1,010
18 months	12.2	78	52	72	65	30	345	40	43	1,042
20 months		79	56	80	74	30	370	43	44	1,050
22 months		82	56	83	75	33	380	44	44	1,059
24 months	13.2	84	56	88	76	33	394	47	46	1,064
3 years	15.2	88	59	89	77	37	418	48	49	1,141
4 years	17.3	99	73	90	85	39	516	58	56	1,191
5 years	19.4	106	85	107	104	47	596	65	64	1,237
6 years	21.9	109	94	121	122	58	642	68	67	1,243

Table II. Average Weights and Measurements of Normal Organs—Continued
(*Infants and Children*)

Age	Body weight M**	Body length	Heart	Lungs		Spleen	Liver	Kidneys		Brain
				right	left			right	left	
	kg	*cm*	*gm*	*gm*	*gm*	*gm*	*gm*	*gm*	*gm*	*gm*
7 years	24.6	113	100	130	123	66	680	69	70	1,263
8 years	27.7	119	110	150	140	69	736	74	75	1,273
9 years	31.0	125	115	174	152	73	756	82	83	1,275
10 years	34.8	130	116	177	166	85	852	92	95	1,290
11 years	38.8	135	122	201	190	87	909	94	95	1,320
12 years	43.2	139	124	--------	--------	93	936	95	96	1,351

* Table II is reprinted from Autopsy Diagnosis and Technic, 4th Edition, 1958, by permission of Otto Saphir, the author, and Paul B. Hoeber, Inc., New York, the publisher.

** Means.

Table III. Organ Weight in Relation to Body Weight in Newborn Infants
(Compiled from Tables by Streeter, Potter and Adair)*

	Body Weight, Gm								
	250–750	750–1,250	1,250–1,750	1,750–2,250	2,250–2,750	2,750–3,250	3,250–3,750	3,750–4,250	Over 4,250
ORGAN	Arithmetical Mean, Gm								
Thyroid	0.5	1.1	1.3	1.4	1.8	1.8	2.4	2.4	2.9
Thymus	1.4	3.1	5.1	8.5	9.3	9.9	10.8	15.3	12.8
Heart	4.6	7.6	10.8	14.5	17.9	20.1	21.7	25.4	29.3
Lungs	15.0	25.1	33.7	44.2	49.5	54.7	59.4	64.0	77.9
Liver	31.5	49.2	66.3	87.9	105.8	140.4	151.5	185.1	229.0
Spleen	1.0	2.1	4.0	5.8	7.6	9.7	11.1	12.2	13.0
Pancreas	0.6	1.2	1.6	2.1	2.8	3.4	3.6	3.9	4.6
Kidneys	5.3	9.7	13.6	18.3	21.1	23.6	26.6	29.3	32.2
Adrenals	2.5	3.3	4.3	5.3	6.9	7.6	9.3	10.5	12.5
Brain	82.8	160.6	226.8	289.2	332.6	390.9	429.6	402.9	456.0
Mean body wt.	555.0	999.0	1,477.0	2,006.0	2,508.0	3,005.0	3,439.0	3,945.0	4,662.0
	Length								
Foot-length (mm)	40.2	49.6	----------	58.2	66.3	----------	73.8		
Crown-heel (cm)	30.6	36.5	41.5	45.7	48.4	50.9	52.6	54.0	55.3
Crown-rump (cm)	21.0	24.7	27.9	30.9	32.9	34.8	36.3	37.3	39.0
	Interval between 1st day of last menstrual period and delivery								
Days	167	195	217	248	258	272	279	287	291
Lunar Months (Approx.)	6	7	7½	8–8½	9	9½	10	10¼	10½

* Table III is reprinted from Fetal and Neonatal Death by E. L. Potter and F. L. Adair, by permission of the University of Chicago Press, copyright 1940 and 1949 by The University of Chicago. All rights reserved. Published 1940; Second Edition 1949; and Second Impression 1950. Composed and printed by the University of Chicago Press, Chicago, Illinois, U.S.A.

*Table IV. Criteria for Classification as to Period of Development**

(Chicago Lying-In Hospital)

Abortion:

1. Length, less than 280 mm.
2. Weight, less than 400 gm.
3. Gestation, less than 22 weeks.

Premature:

A. Previable:

1. Length, from 280 to 349 mm.
2. Weight, from 400 to 999 gm.
3. Gestation, from 22 through 28 weeks.

B. Viable:

1. Length, from 350 to 469 mm.
2. Weight, from 1000 to 2499 gm.
3. Gestation, from 29 through 38 weeks.

Term:

1. Length, from 470 to 540 mm.
2. Weight, from 2500 to 4500 gm.
3. Gestation, from 39 through 42 weeks.

Postmature:

1. Length, more than 540 mm.
2. Weight, more than 4500 gm.
3. Gestation, more than 42 weeks.

INDEX

BY ORDER OF THE SECRETARIES OF THE AEMY, THE NAVY, AND THE AIR FORCE:

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8–551 (1)
8–563 (1)
8–564 (1)
8–565 (2)
8–566 (2)
8–567 (2)
8–581 (2)
8–650 (2)

Active Army:
NG: Same as Active Army.
USAR: Same as Active Army.
For explanation of abbreviations used, see AR 320–50.

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